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THE HERMES-MODEL FOR DENMARK

Frits Møller Andersen

Abstract. This report presents the first version of the Danish HERMES model which is a macro-economic model developed for the Commission of the European Communities to be used by the Commission for economic analyses and forecasts. Similar models are developed for the other EEC countries and in order to perform multinational studies the national models are interlinked into a multinational model.
The model is a medium-term econometric model where special attention is given to analysing structural changes, capacity effects of investments and the energy-economy interactions. In the Danish model production is determined for 9 branches and the total private consumption is divided into 15 categories of consumer goods. Capacity effects of investments are attempted described by the introduction of a putty-clay production function and the energy-economy interactions are analysed by treating energy as a separate factor of production and as specific categories of consumer goods.
Besides presenting the overall structure and the specific equations chosen for the first version of the Danish model the report gives an overview over the alternative specifications tested but rejected for the present version of the model. The report is concluded with an analysis of the model's ability to describe the past development and a few multiplicator analyses for central variables of the model.

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PREFACE

The HERMES-model is a multi-national macro-sectoral econometric model developed for the Commission of the European Communities to replace the Comet model.

A main feature in developing the model has been to develop similar structured national models for all the EEC-countries and to link these into a multi-national model, i.e. the national models are based on the same theoretical set up, and as a start the equations were given similar specifications. However, in order to obtain operational models, as the estimation results for the different national models were not equally satisfactory, the specification of individual equations were allowed to differ from model to model, but still the theoretical set up and the overall structure of the national models is fairly similar.

A few main characteristics of the national models are that the production is split into 9 branches, that the private household consumption is split into categories of consumer goods using a demand system, that energy is considered both as a consumer good and as a factor of production and that the production capacity and factor demand in the industrial branches is attempted described by a putty-clay production function.

This report concentrates on the Danish national HERMES-model and presents the specifications chosen, and to complete the picture, some of the specifications tested but rejected. Chapter 1 of the report presents the overall structure of the model, the chapters 2 to 6 contain the results for the main blocks of the model, the private household consumption, the production and investments, the price and wage-rates, the international trade and finally the energy block. Finally, some tests and multiplicator analyses are shown in chapter 7.

1. THE OVERALL CHARACTERISTICS AND STRUCTURE OF THE MODEL

The HERMES-model is a medium-term model formulated in the tradition of Keynesian demand models supplemented with elements from the neoclassical theory. That the model is a medium-term model has implications for both the central questions and the interactions analysed within the model and the mathematical specifications used. In the medium-term, opposed to the short-term two subjects of special interest are structual changes and supply effects or the effect of investments on the production capacity. Analyses of structural changes require that the production is determined at a branch level and that the demand is determined by categories of final demand and by categories of consumer goods. The model operates with 9 branches, 6 categories of final demand and 15 categories of consumer goods. Supply effects are included in the model by the introduction of a putty-clay production function determining the output capacity per branch. Unfortunately this has been only partly succesful for the industrial branches, and further research has to be put into this subject before the model may be said to give a proper representation of supply effects.

Concerning the mathematical specifications in view of controlling the medium-term properties of the model, it is necessary to identify the equilibrium levels of the explained variables and to model the adjustment towards these levels explicitly. In the specification of the equations this is obtained by using the error-correction mechanism.

Another main characteristic of the HERMES-model is that special attention is given to the treatment of energy. The development of the model was started in 1981 where, due to the energy price increases in 1973 and 1978, much research was devoted to determining the interactions between energy and economics. In the model the energy consumption by branches is treated as a factor of production in line with capital and labour, and the energy consumption by households is determined as three separate categories of consumer goods. Further the total energy consumption by branch and consumer category is split into demand for types of fuels in an energy sub-model.

Of areas where the model at present is limited one may mention that the financial sector is exogenous and, that the income and expenditure of the public sector is modelled at a much more aggregate level than what is common in models used to evaluate the effects of national fiscal policies.

A simplified flow chart of the unlinked Danish model is shown in Fig. 1 where the endogenous variables are given within $\square$ and the exogenous variables are given within $\diamond$.

The most important exogenous variables are the direct and indirect tax rates, the import prices and the exchange rate, the interest rate, the public employment and the active population.

The categories of final demand, private household consumption, intermediary imports, investments, public consumption, changes of stock and exports are transformed to total demand per branch using constant input/output coefficients. The split of total demand between domestic production and imports is determined by endogenous determined import-shares.

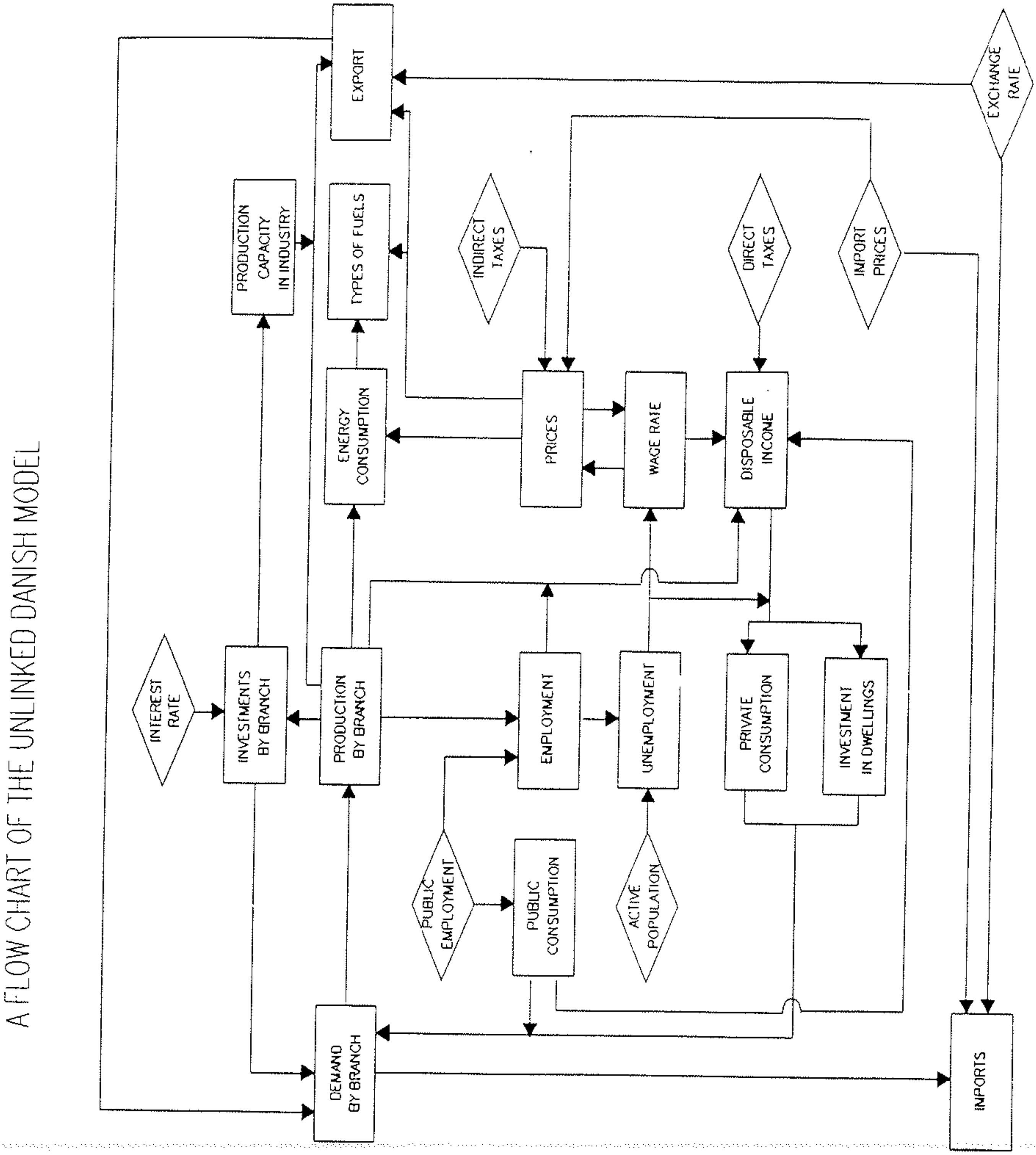
A FLOW CHART OF THE UNLINKED DANISH MODEL
EXPORT
PRODUCTION CAPACITY IN INDUSTRY
TYPES OF FUELS
INDIRECT TAXES
DIRECT TAXES
IMPORT PRICES
EXCHANGE RATE
ENERGY CONSUMPTION
PRICES
WAGE RATE
DISPOSABLE INCOME
INTEREST RATE
INVESTMENTS BY BRANCH
PRODUCTION BY BRANCH
EMPLOYMENT
UNEMPLOYMENT
PRIVATE CONSUMPTION
INVESTMENT IN DWELLINGS
PUBLIC EMPLOYMENT
PUBLIC CONSUMPTION
ACTIVE POPULATION
DEMAND BY BRANCH
IMPORTS

Figure 1.

The domestic production by branch determines the intermediary input demand, the employment, the investments and the total energy consumption by branch. For the industrial branches the investments determine the production capacity via a putty-clay production function. The total energy consumption by branch and the fuel prices determine the fuel consumption by branch; the split between fuels is determined by a translog budget share system. The employment and the active population determine the unemployment via an identity and the wage rate is determined by a Phillips-curve. Prices are determined by the cost of production, the import prices and the indirect taxes. The disposable income is determined by an identity from wage and other income and the direct taxes. The total private household consumption depends of the real disposable income and the unemployment rate, and the total consumption is split into 15 categories of consumer goods using the LES-model.

The investments in dwellings are determined similar to the private household consumption and depends of the real disposable income and the unempolyment. Finally the export is determined from the production, the production capacity, the output price and the exchange rate.

In total the model contains 1053 equations of which 160 are behavioural estimated equations. A listing of the model is given in Appendix A and a list of variables is given in Appendix B.

2. THE PRIVATE HOUSEHOLD CONSUMPTION

A basic assumption underlying the set up chosen to describe the private household consumption is that there is separability between the consumer's decisions of how much to consume presently and of how to allocate the total consumption between different commodities. Accepting this assumption the private household consumption is determined in the following two stages. In the first stage the total private consumption of Danish residents is determined by a macro-economic consumption function, and in the second stage the total consumer budget including non-residents expenditures in Denmark is allocated between 15 categories of consumer goods using the linear expenditure system. The inclusion of the non-residents expenditures in Denmark in the second stage is due to data problems and from a theoretical point of view not quite satisfactory, however, from a practical point of view the problem is of minor importance.

2.1. The macro-economic consumption function

The specification of the macro-economic consumption function is based on the assumption that over time real consumption is adjusted towards some theoretical "permanent" consumption level. This level is expressed as a fraction of wealth and depends among other variables on wealth itself. Approximating wealth by the real disposable income we have that current consumption depends on current and lagged values of the real disposable income. The lag structure specified is the geometric lag structure. Besides real disposable income current consumption depends on a series of factors. Of factors tested by the inclusion of different proxy variables one may mention the rate of inflation, real interest effects, distributional effects and uncertainties with respect to future income. The only effect that becomes statistical significant is uncertainties with respect to future income proxied by changes in the unemployment rate.

In analytical form the chosen macro-economic consumption function may be written as:

$$\text{eq. 2.1.}\quad \log C_t = a_0 + a_1(1-\lambda)\sum_{i=0}^{\infty} \lambda^i \log(YDH_{t-i}/PCH_{t-i})$$

$$+\ a_2\ \Delta UR_t$$

where C_t is the private consumption in constant prices

YDH_t is the disposable income

PCH_t is a price-index for private consumption

and UR_t is the unemployment rate.

As the right hand side of eq. 2.1 consists of an indefinite number of terms it can not be estimated. Therefore to be estimated eq. 2.1 is reformulated as:

$$\text{eq. 2.2.}\quad \log C_t = (1-\lambda)a_0 + (1-\lambda)a_1 \log(YDH_t/PCH_t)$$

$$+\ a_2(\Delta UR_t - \lambda\Delta UR_{t-1}) + \lambda \log C_{t-1} + V_t$$

where V_t is an error term assumed to be distributed $N(0, \sigma^2_v)$.

Equation 2.2 is estimated on data for the period 1968 to 1986, and in order to catch some very large increases in the private consumption in 1985 and 1986 the final equation includes a dummy variable which is one in 1985 and 1986 and zero elsewhere. Other studies indicate that the large increases in the private consumption in 1985 and 1986 are due to capital gains caused by a large decrease in the nominal interest rate. However, including the interest rate in the equation has not proven significant.

The estimated equation with t-values in brackets is written as:

$$\text{eq. 2.3.}\quad \log C_t = \underset{(4.23)}{(1-0.395)}\cdot\underset{(1.07)}{0.678}$$

$$+\ (1-0.395)\cdot\underset{(17.43)}{0.924}\cdot\log(YDH_t/PCH_t)$$

$$-\ \underset{(-2.17)}{0.678}\cdot(\Delta UR_t - 0.395\cdot\Delta UR_{t-1}) + \underset{(2.63)}{0.028}\cdot D8586$$

$$+\ 0.395\cdot\log C_{t-1}$$

$R^2 = 0.99$ DW = 1.28 Durbin's h* = 1.72

Looking at eq. 2.3 the explanatory power is satisfactory, but the Durbin's h-test which is distributed N(0,1) indicates slight autocorrelation problems, however, as the test is a large sample test and the estimation is based on 19 observations the test is not very strong.

Looking at the estimated coefficients the long-term income elasticity is 0.92 and the first year elasticity is 0.56. The first year adjustment towards a new equilibrium is about 60%. The equilibrium effect of changes in the unemployment rate is that for each per cent point the unemployment rate increases the private consumption decreases by 0.67 per cent.

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* Johnston (1972) "Econometric methods" 2nd edition, UC Grav-Hill, Kogahusha Ltd. p. 313.

2.2. The consumer demand system

2.2.1. Introduction

The total private consumption is allocated between the 15 categories of consumer goods given in table 2.1 using the linear expenditure system. As alternatives to the linear expenditure system the preference independent and the block independent cases of the Rotterdam model have been tested*, however, as historical simulations with the different cases of the Rotterdam model show that the model accumulates very large errors, the simpler linear expenditure system is chosen for the present version for the Danish HERMES-model.

The categories of consumer goods shown in table 2.1 are defined in order to be applicable for each of the EEC-countries. For Denmark 15 categories seems quite a lot and a number of categories are very small and unimportant. In 1975 the budget share for each of the categories 6 Domestic services, 11 Communication and 12 Medical care and health expenditures was less than 2%. Nevertheless to keep the comparability between the national models in the Danish model the private consumption is allocated between the 15 categories of consumer goods.

* Private household consumption, some results for Denmark, Nov. 82.

Table 2.1. Aggregation of the private consumption

	Eurostat classification	Classification in the Danish national account
1. A. Food, drink and tobacco	D1	1-19
2. B. Clothing and footwear	D2	20-21
3. C. Rents	D31	22
4. D. Fuels and power for heating	D32	25-27
5. E Power for doestic use	D32	24
6. F. Domestic services	D46	35
7. G. Furniture, furnishings and household equipment and household operation	D41-45	28-34
8. H. Personal transport equipment	D61	41
9. I. Fuels for personal transportation	D62	43
10. J. Purchased transport	D63	45
11. K. Communication	D64	46
12. L. Medical and health expenditures	D5	36-40
13. M. Recreation, entertainment, education and culture	D7	47-53
14. N. Hotels, restaurants, cafés, financial services, package tours, personal care and goods n.e.c	D8 +residual	23,42,44, 54-63
15. O. Expenditures of resident abroad	MCU,MCØ	65
Non-resident expenditures in Denmark		64
Consumption of private non-profit institutions		66
Final consumption of households on the economic territory		CHØ=1-14

2.2.2. Some fundamental concepts of consumer demand theory

The theoretical basis for the consumer demand system is the neoclassical theory of consumer behaviour, that is given prices and the total consumption budget, consumers aim at maximizing utility described by a well-behaved utility function. Mathematically this may be expressed as:

eq. 2.1. $\max v(q)$ subject to $p'q \leqslant m$ and $q \geqslant o$

where $v(q)$ is a well-behaved twice differentiable utility function dependent on the vector of quantities consumed q, p is the vector of commodity prices and m is the total consumption budget.

The first-order conditions for the maximization of $v(q)$ are given by

eq. 2.2. $u - \lambda p = o$ and
$p'q = m$

where $u = \delta v/\delta q$ is a vector of partial differentials of v with respect to q and λ is a Lagrange multiplier. The solution of these first-order conditions gives a set of demand equations in m and the vector of commodity prices

eq. 2.3. $q = q(m,p)$

With n commodities this gives n equations and $n(n+1)$ responces to be estimated. Using annual time-series data and 15 categories of consumer goods the number of responces to be estimated have to be reduced drastically. This is done by imposing restrictions which are partly of a theoretical nature derived from the second-order conditions for the utility maximization and partly of a more ad-hoc nature.

Total differentiating the first-order conditions (2.2) gives

eq. 2.4. $$\begin{bmatrix} U & p \\ p' & 0 \end{bmatrix} \begin{bmatrix} dp \\ -d\lambda \end{bmatrix} = \begin{bmatrix} \lambda dp \\ dm - q'dp \end{bmatrix}$$

where U is the Hessian of v, i.e. $U = \delta^2 v / \delta q_i \delta q_j$. This equation is known as the "fundamental matrix equation of the theory of consumer demand" (Brown and Deaton, 1972). For the demand equations 2.3 to represent a maximum we must have that

$$x'Ux \leqslant 0 \text{ for all } x \text{ such that } p'x = 0$$

which is sufficient to ensure that $\begin{bmatrix} U & p \\ p' & 0 \end{bmatrix}$ is non-singular.

If we further assume that U is non-singular, which an appropriate transformation of v always may ensure, the solution to eq. 2.4 is given by:

eq. 2.5. $$\begin{bmatrix} dq \\ d\lambda \end{bmatrix} = (p'U^{-1}p)^{-1} \begin{bmatrix} (p'U^{-1}p)U^{-1} - U^{-1}pp'U^{-1} & U^{-1}p \\ p'U^{-1} & -1 \end{bmatrix}$$

$$\begin{bmatrix} \lambda dp \\ dm - q'dp \end{bmatrix}$$

from which we have the following derivatives

eq. 2.6. $$\frac{dq}{dm} = q_m = (p'U^{-1}p)^{-1} U^{-1}p$$ (income derivatives)

eq. 2.7. $$\frac{dq}{dp} = Q_p = (\lambda U^{-1} - q_m q_m' \phi m) - q_m q'$$ (price derivatives)

$$\text{eq. 2.8.} \quad \frac{d\lambda}{dp} = \lambda_p = -\lambda(q_m+(\phi\, m)^{-1}q)$$

$$\text{eq. 2.9.} \quad \frac{d\lambda}{dm} = \lambda_m = \lambda(\phi\, m)^{-1}$$

where $\phi = \frac{\lambda}{m}\,(p'U^{-1}p) = \left(\frac{d \log \lambda}{d \log m}\right)^{-1}$

Equation 2.7 is the Slutsky decomposition of price responces into the substitution and income effects. That $(\lambda U^{-1} - q_m q_m' \phi\, m) = S$ is the Slutsky matrix of compensated price responces, when income is set so that utility is unaltered after a price change, may be seen from the following reasoning. From the first-order conditions we have

$$\text{eq. 2.10.} \quad dv = (dv/dq)dq = u'dq = \lambda p'dq \quad \text{and}$$

$$\text{eq. 2.11.} \quad p'dq = dm - q'dp$$

Combining these equations and setting dv (the change in utility) to zero we have

$$\text{eq. 2.12.} \quad dv = \lambda(dm-q'dp) = 0$$

which is satisfied when $(dm-q'dp) = 0$. Inserting this in eq. 2.5 we have

$$\text{eq. 2.13.} \quad \frac{dq}{dp}\ \text{(compensated)} = S = \lambda U^{-1} - q_m q_m' \phi\, m$$

which is the matrix of price responces that is relevant for imposing restrictions on the demand equations. The restrictions normally imposed on the demand equations are the adding-up, the homogenity, the symmetry and the negativity restrictions.

The adding-up restriction is a consequence of the budget constraint and states that after a reallocation of the budget due to price or budget changes total consumption must continue to exhaust the budget. The restrictions imposed are derived by premultiplying the equations 2.6 and 2.7 by p, and amounts to:

eq. 2.14. $p'q_m = 1$ and

eq. 2.15. $p'[Q_p+q_m q'] = p'S = 0$

The homogenity condition amounts to the assumption that a proportional change of all the prices and the monetary consumer budget leaves the choice of commodities unchanged or, equivalently, that the demand equations are homogeneous of degree zero in p and m. The restrictions imposed by this assumption are

eq. 2.16. $[Q_p+q_m q']p = Sp = 0$

The symmetry restriction amounts to the Slutsky matrix being symmetric, that is

eq. 2.17. $S = S'$

This restriction rules out the existence of a sequence of price and budget changes leading the consumer to positions each preferred to the previous one but in the end leading back to the starting point.

The negativity restriction follows from the second-order conditions for the maximization and implies that the Slutsky matrix is negative semi-definit, that is

eq. 2.18. $x'Sx \leqslant o$ for all x

This condition implies a number of inequality constraints on the elements of the substitution matrix S, the most familiar being that the diagonal elements should be negative. These inequality constraints are seldom imposed in the estimation but are checked on the estimates afterwards.

Imposing the adding up, the homogenity and the symmetry restrictions on the demand equations the original n(n+1) free responces are reduced to (n-1)(1/2n+1) responces to be estimated. With 15 categories of consumer goods this gives 119 responces to be estimated. Using annual time-series the estimation of 119 responces is not manageable in practice. The additional restriction imposed on the linear expenditure system is the assumption of strong separability or preference-independence. This amounts to assuming that the utility function may be written as the sum of n functions each involving the quantity of only one commodity group, that is

eq. 2.19. $$U(q) = \sum_{i=1}^{n} U_i(q_i)$$

where q_i is the quantity of commodity group i. The consequence of this assumption is that the marginal utility of each commodity is independent of the quantities consumed of the other commodities, or equivalently, that the Hessian of the utility function is diagonal.

2.2.3. The linear expenditure system

The linear expenditure system (LES) developed by Stone (1954) is based on the Klein-Rubin utility function

$$\text{eq. 2.20.}\quad U(q_1, \ldots q_n) = \sum_{i=1}^{n} \mu_i \log(q_i - \gamma_i)$$

where μ_i and γ_i are parameters characterizing the function. For the function to be defined, we must have that

$$\text{eq. 2.21.}\quad q_i - \gamma_i > 0$$

Differentiating the utility function eq. 2.20 gives

$$\text{eq. 2.22.}\quad \frac{\delta U}{\delta q_i} = \frac{\mu_i}{(q_i - \gamma_i)} \qquad i = 1 \ldots n$$

from which it is seen that the marginal utility of any commodity is independent of the quantities consumed of the other commodities, i.e. the assumption of preference-independence. Further, as the marginal utility of any commodity should be positive, we have

$$\text{eq. 2.23.}\quad \mu_i > 0 \qquad i = 1 \ldots n$$

The second-order derivatives of the utility function are given by

$$\text{eq. 2.24.}\quad \frac{\delta U^2}{\delta q_i^2} = \frac{-\mu_i}{(q_i - \gamma_i)^2} \quad \text{and} \quad \frac{\delta U^2}{\delta q_i \, \delta q_j} = 0$$

that is, given the conditions eq. 2.21 and eq. 2.23 the Hessian matrix is diagonal and negative semi-definite.

The demand equations implied by the Klein-Rubin utility functions (eq. 2.20) are derived from the first-order conditions for the utility maximization (eq. 2.21), and are

$$\text{eq. 2.25.} \quad \frac{\delta U}{\delta q_i} = \lambda p_i = \frac{\mu_i}{(q_i - \gamma_i)}$$

which is reformulated as

$$\text{eq. 2.26.} \quad \mu_i = \lambda(q_i p_i - \gamma_i p_i)$$

Summing over i and imposing the adding-up restrictions

$$\sum_{i}^{n} \mu_i = 1,$$

we have

$$\text{eq. 2.27.} \quad \sum_i \mu_i = \lambda(m - \sum_i \gamma_i p_i) = 1$$

which solved for λ gives

$$\text{eq. 2.28.} \quad \lambda = (m - \sum_i \gamma_i p_i)^{-1}$$

Using this to eliminate λ from eq. 2.26 gives the LES-equations

$$\text{eq. 2.29.} \quad q_i p_i = \gamma_i p_i + \mu_i(m - \sum_k \gamma_k p_k)$$

determining the expenditure on commodity i as a linear function of the total expenditure m and the n commodity prices p_i. Often these equations are given the following quite simple interpretation. The constants γ_i are interpreted as necessary or committed quantities which the consumer buys first. Having purchased these initial quantities, the remaining consumer budget $m - \sum_i \gamma_i p_i$ is spent in fixed proportions μ_i on the commodities.

The interpretation of γ_i as necessary quantities implies that $\gamma_i \geqslant 0$. However, as $\gamma_i \geqslant 0$ excludes price-elastic commodities, one should allow for $\gamma_i < 0$ and not take the interpretation of γ_i too literally.

That the LES-equations satisfy the conditions of adding-up, homogenity, symmetry and negativity may be seen from the following reasonings.

Summing eq. 2.29 gives

eq. 2.30. $$\sum_i q_i p_i = \sum_i \gamma_i p_i + \sum_i \left[\mu_i (m - \sum_k \gamma_k p_k)\right] =$$

$$\sum_i \gamma_i p_i + (m - \sum_k \gamma_k p_k) \sum_i \mu_i$$

which is satisfied when $\sum_i \mu_i = 1$

Dividing eq. 2.29 by the price p_i gives the demand equations:

eq. 2.31. $$q_i = \gamma_i + \mu_i \left(\frac{m - \sum_k \gamma_k p_k}{p_i}\right) \qquad i = 1 \ldots n$$

from which it is seen that an equal percentage change in all the prices and in the consumer budget leaves the demand unchanged, that is the demand equations are homogeneous of degree zero in m and p_i.

The fulfilment of the symmetry and negativity conditions follows directly from the diagonality and negative semi-definiteness of the Hessian-matrix (see eq. 2.24).

The income and price elasticies derived from eq. 2.31 are given by:

eq. 2.32. $$\frac{\delta \log q_i}{\delta \log m} = \mu_i \frac{m}{q_i p_i} = \mu_i w_i^{-1} \quad \text{(income elasticities)}$$

$$\frac{\delta \log q_i}{\delta \log p_i} = -1+(1-\mu_i)\frac{\gamma_i}{q_i} \quad \text{(own-price elasticities)}$$

$$\frac{\delta \log q_i}{\delta \log p_j} = -\mu_i \frac{\gamma_j p_j}{q_i p_i} \quad \text{for } i \neq j \quad \text{(cross-price elasticities)}$$

From the own and cross-price elasticities it is seen that for a commodity to be price-elastic it is required that $\gamma_i \leqslant 0$ and if this is the case the commodity will be a gross-substitute for each of the other commodities.

Calculating the compensated price elasticies (see eq. 2.13) for the LES we have

eq. 2.33. $$s_{ij} = -\frac{\mu_i}{p_i}\frac{\mu_j}{p_j}(m-\sum_k p_k \gamma_k) \quad \text{for } i \neq j$$

As $\mu_i \geqslant 0$, $i = 1 \ldots n$ and $(m-\sum_k p_k \gamma_k) \geqslant 0$ we have that $s_{ij} \leqslant 0$ for all pairs of commodities, that is the linear expenditure system excludes Hicks-Allen complementarity between any commodities.

2.2.4. Estimation of the linear expenditure system

To estimate the LES-model one might start from eq. 2.29 adding an error term and estimate equations of the form

$$\text{eq. } 2.34. \quad q_i^t p_i^t = \gamma_i p_i^t + \mu_i \left(m^t - \sum_k \gamma_k p_k^t\right) + e_i^t \qquad i = 1 \ldots n$$

where e_i^t is an error-term. However, simultaneous estimation of these equations leads to strongly positive autocorrelated error-terms with Durbin-Watson statistics in the order of 0.1. In addition the error-terms are heteroscedastic; large values of the dependent variable leads to larger error-terms than small values of the dependent variable. In order to overcome these problems, equation 2.34 is reformulated in first-differences and normalized by the total expenditures, that is the observable equations are given by:

$$\text{eq. } 2.35. \quad \frac{\Delta(q_i^t p_i^t)}{\bar{m}^t} = \mu_i \frac{\Delta m^t}{\bar{m}^t} + (1-\mu_i)\gamma_i \frac{\Delta p_i^t}{\bar{m}^t} - \mu_i \sum_{k \neq i} \gamma_k \frac{\Delta p_k^t}{\bar{m}^t} + e_i^t$$

where $\bar{m}^t = (m^t + m^{t-1})/2$. Summing eq. 2.35 over the n equations the price-term vanishes and both sides sum identically to $\sum_i [\Delta(q_i^t p_i^t)/\bar{m}^t]$. This means that $\sum_i e_i^t = 0$ for all t, and therefore the disturbance covariance matrix is singular and at most of rank n-1. Therefore one of the equations has to be excluded from the estimation, however, the μ_i of the excluded equation may be calculated from $\sum_i \mu_i = 1$ and using a proper estimation technique the estimates are independent of which equation is excluded (see Barten, 1977).

The equations are estimated using TSP method LSQ. This method is an iterative simultaneous-estimation method that minimizes the negative of the log-likelihood function, which in this case is a constant plus the log of the determinant of the covariance matrix of the regression disturbances. This method gives consistent and asymptatic efficient estimates. The estimation period is 1966 to 81 and the estimation results are given in table 2.2.

Looking at the estimation results although it is difficult to have any firm belief concerning the size of income and price elastics for different categories of consumer goods the implied elasticities given in column 4 and 6 of table 2.2 give rise to the following comments. Looking at the income elasticities for most of the categories of consumer goods the size (and the mutual order of magnitude) of the elasticity is acceptable but for some of the categories the elasticity is questionable. An elasticity of 0.3 for rents is extremely low and an elasticity of 1.7 for heating is somewhat high, especially it is surprising and not quite reasonable that the elasticity for heating is higher than the elasticities for both power and transport fuels. Concerning the elasticity for transport equipment although it is just above 1 it seems somewhat low and concerning expenditures abroad although an elasticity well above 1 seems reasonable an elasticity of 2.6 appears fairly high.

Table 2.2. Estimation results for the LES-system

	Budget w_i (1975)	Consump-tion q_i(1975)	Coeffi-cient μ_i	Income-elast $dq_i/dm\ ^m/q_i$	Coeffi-cient γ_i	Own-price elast $dq_i/dp_i\ ^{p_i}/q_i$	Durbin-Watson	RMSE	MAPE
	1	2	3	4	5	6	7	8	9
1. Food	0.260	6390.8	0.2440	0.938	1154.35	-0.863	2.33	0.0041	0.0123
			(0.0133)		(2.87)				
2. Cloth	0.062	1518.1	0.0864	1.394	-656.49	-1.395	2.25	0.0022	0.0266
			(0.0069)		(0.99)				
3. Rents	0.161	3957.0	0.0520	0.323	3936.16	-0.057	0.61	0.0024	0.0143
			(0.0129)		(218.82)				
4. Heating	0.035	857.7	0.0585	1.671	143.89	-0.842	1.55	0.0042	0.0869
			(0.0133)		(0.98)				
5. Power	0.020	497.6	0.0229	1.145	140.52	-0.724	1.51	0.0019	0.0881
			(0.0061)		(0.31)				
6. Dom.serv.	0.005	125.9	0.0028	0.560	3.72	-0.971	0.87	0.0002	0.0330
			(0.0007)		(0.30)				
7. Furnich	0.082	2013.0	0.0953	1.162	-314.82	-1.141	1.84	0.0021	0.0228
			(0.0069)		(3.52)				
8. Tr.eq.	0.057	1109.3	0.0600	1.053	12.60	-0.989	2.09	0.0085	0.1656
			(0.0269)		(7.09)				
9 Tr.fuel.	0.030	744.1	0.0394	1.313	100.14	-0.871	1.67	0.0017	0.0478
			(0.0055)		(0.19)				
10. Tr.serv.	0.025	625.3	0.0311	1.244	6.21	-0.990	1.26	0.0015	0.0404
			(0.0047)		(8.87)				
11. Comm.	0.012	288.9	0.0154	1.283	18.02	-0.937	2.32	0.0005	0.0310
			(0.0017)		(0.56)				
12. Medical	0.019	477.6	0.0155	0.816	171.81	-0.646	1.15	0.0008	0.0336
			(0.0024)		(0.07)				
13. Recrea	0.088	2155.3	0.0879	0.999	692.08	-0.707	1.20	0.0019	0.0137
			(0.0062)		(9.72)				
14. Hotels	0.126	3099.3	0.1421	1.128	641.00	-0.823	1.72	0.0024	0.0134
			(0.0078)		(0.98)				
15. Exp.abr.	0.018	723.5	0.0466	2.589	34.47	-0.955			
					(0.12)				

LF= 1508.04

* standard error in brackets.

Looking at the own-price elasticities in general they appear to be very high implying that the consumption of relatively aggregated categories of consumer goods should be very price-sensitive. For disaggregated categories of consumer goods such as different kinds of food, between which substitution possibilities are considerable, high own-price elasticities seem reasonable, but for food as an aggregate one would expect a rather low price-sensitivity. At the extreme two of the categories, clothing and furnishing are price-elastic, that is the own-price elasticities are less than -1.0 and the estimated γ_i-coefficients are negative. This contradicts with the interpretation of the γ_i-coefficients as necessary quantities, however, as mentioned in section 2.2.3 this interpretation should not be taken too literally.

Looking at the Durban-Watson statistics signigicant positive autocorrelation is observed for the categories rents and domestic services. This indicates some specification error problems for these relations, which may not come as a surprise. In the short run expenditure on rents is more or less fixed and adjustments to changes in income and prices may take some years. The very low income and own-price elasticities for rents supports that expenditure on rents is more or less fixed in the short run. For domestic services expenditure has declined trendwise largely independent of changes in income and prices, however, as domestic services accounts for less than 1% of the consumer budget, specification error problems for this category are relatively unimportant.

Finally, looking at the goodness of fit measured by the root mean squared error (RMSE) and the mean absolute per cent error (MAPE) in the budget shares in general the values are acceptable, however, for the categories transport equipment, heating and power the values are rather high. Concerning transport equipment the large MAPE is to a large extent caused by large errors for the years 1974 and 1980 in which the budget share for this category changed drastically. Similarly for the categories heating and power large errors are observed for the years with large changes in the budget shares, that is the model is not very well suited for explaining drastic changes.

2.3. Gross fixed capital formation in the construction of dwellings

The investment in dwellings is one of the central variables of the model and actually quite difficult to explain. One of the problems is that the housing market is heavily regulated and that the size of the investments in dwellings is, at least to some extent a policy variable used to regulate the economic activity; the construction of dwellings is a typical home market industry with a fairly low import content.

In the model the description of the investments in dwellings is based on purely economic considerations determining the desired long term level of house construction to which the actual investments are adjusted. The main determinants tested are the wealth of households, expectations and uncertainties of future income, the relative price of houses and the rate of inflation.

In the investment equations tested the wealth of households and the expectations of future income are approximated by current and lagged values of the real disposable income and the lag-structure is specified as a geometric lag. The relative price of houses is approximated by the price of residential investments deflated by the price of household consumption and multiplied by the sum of the long-term interest rate and a constant depriciation rate. This term may be interpreted as the relative user costs of houses. The effect of inflation is incorporated through relative changes of the price of household consumption and finally uncertainty with respect to future income is incorporated by the inclusion of the unemployment rate as a proxy variable. That is the investment equation tested has the form:

$$\text{eq. 2.36.} \quad \log(IRO_t) = \alpha_0 + \alpha_1(1-\lambda)\sum_{i=0}^{\infty} \lambda^i \log(YDH_{t-i}/PCH_{t-i}) + \alpha_2 \log(PIR_t(r_t+\delta)/PCH_t) + \alpha_3 \log(PCH_t/PCH_{t-1}) + \alpha_4 UR_t$$

where

IRO_t is the construction of dwellings in constant prices
YDH_t is the gross disposable income of households
PIR_t is the price of the construction of dwellings
PCH_t is the price of household consumption
r is the long-term interest rate
δ is a constant depriciation rate set to 3.33% p.a.
and UR_t is the unemployment rate.

As eq. 2.36 contains an indefinite number of terms in the real disposable income this equation is not directly observable. In order to be estimated the equation is transformed using a Koyck-transformation and the observable equation is written as:

eq. 2.37. $\log(IRO_t) = \alpha_0\ (1-\lambda) + \alpha_1\ (1-\lambda)\log(YDH_t/PCH_t) +$

$$\alpha_2\ [\log(PIR_t(r_t+\delta)/PCH_t)-$$

$$\lambda\ \log(PIR_{t-1}(r_{t-1}+\delta)/PCH_{t-1})] +$$

$$\alpha_3\ [\log(PCH_t/PCH_{t-1})-$$

$$\lambda\ \log(PCH_{t-1}/PCH_{t-2})] +$$

$$\alpha_4\ (UR_t-\lambda\ UR_{t-1}) + \lambda\ \log(IRO_{t-1})$$

where the coefficients are interpreted as:

α_0 a constant term

α_1 the long-term income or wealth elasticity > 0

α_2 the own-price or user costs elasticity < 0

α_3 the effect of inflation > 0

α_4 the effect of uncertainty w.r.t. future income < 0

and λ is the annual adjustment rate, $0 < \lambda < 1$.

The estimation results for eq. 2.37 show that neither the coefficient for the user costs (α_2) nor the coefficient for the inflation (α_3) become significant and the equation included into the model is simplified to

eq. 2.39.
$$\log(IRO_t) = \underset{(-0.21)}{-\ 1.669}\ \underset{(5.70)}{(1-0.654)}$$
$$+ \underset{(1.37)}{0.884}\ (1-0.654)\ \log(YDH_t/PCH_t)$$
$$- \underset{(-3.44)}{0.251}(UR_t-0.654\cdot UR_{t-1}) - \underset{(-3.38)}{0.213}\cdot D8082$$
$$+ 0.654\ \log(IRO_{t-1})$$

$R^2 = 0.88$ Durbin's h-test = -1.48 t-values in brackets where D8082 is a dummy-variablee that is one in 1980 to 82 and zero elsewhere. Looking at the estimation result it is noticed that the income elasticity is fairly moderate and not quite significant, however, the effect of uncertainty with regard to future income is fairly strong and highly significant. Finally, the R^2-value indicates a reasonable explanatory power of the eqation and the Durbin's h-test is not able to reject the hypothesis of zero autocorrelation at a 5 per cent level of significance.

3. PRODUCTION AND FACTOR DEMAND

3.1. Introduction

In medium-term models the production block is a central part and concerning HERMES the modelling of this part has been the subject of quite intensive research. Looking at production what characterizes the medium-term opposed to the short-term is, that as the time-horizon is expanded, structural changes and changes in the production capacity become increasingly important.

In order to analyse structural changes it is required that the total production is divided into a number of branches that may develop differently. The branches of the model are presented in section 3.2.

Changes in the production capacity are mainly obtained through new investments and the scrapping of old production capacity. Much of the research devoted to the production block has concentrated on how these capacity effects should be modelled and introduced into the model. Unfortunately the empirical research in this subject has not been as successful as hoped. In the final model a comprehensive description of the capacity effects is given for the industrial branches only, and even for these branches the description is inadequate and raises a number of problems.

The description of the production block for the industrial branches, the different specifications tested, and the specification chosen are given in section 3.3. For the non-industrial branches the factor demand equations are given simple ad-hoc specifications, and these are presented in section 3.4.

A final general feature of the production block is that energy, is treated as a separate factor of production, that is, the model operates with the four factors of production, capital, labour, energy and other intermediary inputs. At the energy level the total energy consumption is split between types of fuels. This will be described in chapter 6: The interfuel substitution model.

3.2. The branches of the model and the determination of the output by branch

The model identifies 9 branches which are obtained as simple aggregates of the two digit NACE-CLIO branch nomenclature. The branches of the model, the NACE-CLIO aggregation and the aggregation of the 117 Danish national accounting branches are given in table 3.1.

Table 3.1. The branches of the model

Branch	NACE-CLIO R25	The Danish national accounting branches
Agriculture	01	1-6
Fuel and power products	06	7,57,91-94
Intermediate goods industry	13,15,17	8,50-56,58,62-68,70
Investment goods industry	19,21,23,25,28	69,71-88
Consumption goods industry	36,42,47-49	9-49,59-61,89-90
Building and construction	53	95
Transport and communication	61,63,65,67	99-105
Other market services	56,59,69A,74	96-98,106-114
Non-market services	86	115-117

The branches of the model are defined such that they should be equal in the national models for each of the EEC-countries. The main distinction behind the disaggregation is that of primary production, industry and services. All the primary production is ascribed to the agricultural branch, that is besides the agricultural production the branch includes forestry and fishing. The industry is disaggregated mainly according to, to which demand category the output is delivered. The energy branch is identified according to energy being treated as a separate factor of production and as separate categories of private household consumption. The other three industrial branches are grouped according to branches mainly delivering to intermediary input in other branches, branches producing investment goods and branches delivering mainly to private consumption. Building and construction are identified as a home market industry and at least for Denmark as a very regulated and cycle sensitive branch. The service sector is divided into transport and communication, other market services (mainly wholesale and retail trade, financial and other business services) and non-market services (mainly producers of government services.

The output by branch is determined from the demand side by identity as the sum of deliveries from the branch to intermediary consumption and the different categories of final consumption, that is as

eq. 3.1. $QFO_i = QQO_i + QHO_i + QGO_i + QIO_i + QSO_i + QXO_i$

where QFO_i is the output by branch i

QQO_i is intermediary deliveries from branch i

QHO_i is deliveries to private household consumption

QGO_i is deliveries to public consumption

QIO_i is deliveries to investments
QSO_i is deliveries to stocks, and
QXO_i is deliveries to export

The transformation from input used in one branch, from the consumption of one category of private household consumption, from investments by a branch and from consumption of the general government to deliveries from branches are determined by an input/output model with endogenous imports, while for deliveries to stocks and exports separate equations are estimated for each branch. Looking at the schematic input/output table shown in figure 3.1, what is determined by the factor demand, investments by branch and the private household consumption are the column sums QOO_j, CO_c and IO_j, at the bottom of the figure.

	Domestic branches	Σ	Cat. of consumer goods	Σ	Investments	Σ	Other final consumption	Σ
Domestic branches	cq_{ij}	QQO_i	ch_{ic}	QHO_i	ci_{ij}	QIO_i	QGO_i QSO_i QXO_i	QFO_i
Branches abroad		MQO_i		MHO_i		MIO_i	MGO_i MSO_i MXO_i	QMO_i
Σ	QOO_j		CO_c		IO_j			

Figure 3.1. A schematic input/output table

The transformation from these column sums to delivering branches is obtained by using the 1975 input/output coefficients, however, especially as the import share of the total deliveries do change, the share delivered from domestic branches to intermediary consumption and categories of final consumption is allowed to vary over time. Consequently the deliveries from the domestic branch i to intermediary consumption is determined as:

eq. 3.2. $$QQO_i^t = (\sum_j cq_{ij} * QOO_j^t) * cq_i^t / cq_i^{75}$$

where cq_{ij} is the input/output coefficient for deliveries from branch i to intermediary consumption by branch j

QOO_j^t is the intermediary consumption by branch j

and $$cq_i^t = \frac{QQO_i^t}{QQO_i^t + MQO_i^t}$$

Similarly the deliveries to private household consumption are determined by

eq. 3.3. $$QHO_i^t = (\sum_c ch_{ic} * CO_c^t) * ch_i^t / ch_i^{75}$$

where $$ch_i = \frac{QHO_i^t}{QHO_i^t + MHO_i^t}$$

and deliveries to investments are determined by

eq. 3.4. $$QIO_i^t = (\sum_j ci_{ij} * IO_j^t) * ci_i^t / ci_i^{75}$$

where $$ci_i^t = \frac{QIO_i^t}{QIO_i^t + MIO_i^t}$$

The development of the shares delivered from domestic branches are determined as dependent of time and a number of dummy-variables, that is

eq. 3.5. $$cq_i^t = f(t, \text{dummies})$$

One might consider to include additional explaining variables in these equations, for instance it could be argued that the share delivered from a domestic branch should depend on the production capacity or the capacity utilization rate of the branch or on the competitive power of the branch, however, this has not been tried and requires further research.

Finally deliveries to stocks are determined by simple ad-hoc relations mainly dependent of the output of the branch and dummy-variables, that is

eq. 3.6. $QSO_i = f(QFO_i, \text{dummies})$

and the equations for deliveries to export will be presented in chapter 5: The external trade.

3.3. The production block for the industrial branches

For the industrial branches the determination of the production capacity and the factor demand is based on the neoclassical theory of cost minimizing behaviour of the producers, that is the producers are assumed to minimize the cost of production subject to the technology described by a production function. The production process is described as a putty-clay production process, that is before an investment is made the producer may choose between investments with different combinations of factor inputs i.e. substitution is possible but once an investment is installed the factor properties are fixed except for possible trendwise technical progress. The technology is described by a production function for the new capacity installed and this function is assumed to exhibit constant returns to scale, that is the technology is described by a unit production function for the new capacity installed. In this context the cost minimizing behaviour of the producers is equivalent to minimizing the discounted present value of the expected costs of producing one unit of output on the new capacity during the lifetime of the investment and the costs are fully described by the unitary cost-function.

$$\text{eq. 3.7.} \quad c_t = \sum_{j=0}^{T} \frac{\Sigma_i \, p_{it+j} \, k_{it}}{(1+r_t)^j} + p_{It} \, k_{It}$$

where k_{it} and k_{It} are respectively the factor inputs and gross investments per unit of output on the new capacity, p_{it+j} and p_{It} are the corresponding expected factor prices and the price on investments, r_t is the long-term interest rate and T is the expected lifetime of the investments. Now assuming that the companies anticipate a trend in the cost of production factors at constant annual rates of π_{it} the cost function simplifies to

$$\text{eq. 3.8.} \quad c_t = \sum_i k_{it} \sum_{j=0}^{T} p_{it} \, (1+\pi_{it})^j/(1+r_t)^j + p_{It} \, k_{It}$$

or

$$\text{eq. 3.9.} \quad c_t = \sum_i k_{it} \, p_{it} \, \Pi_{it} + p_{It} \, k_{It} = \sum_i k_{it} \, P_{it}$$

where the anticipation rate Π_{it} is given by

$$\text{eq. 3.10.} \quad \Pi_{it} = \sum_{j=0}^{T} (1+\pi_{it})^j/(1+r_t)^j$$

$$= \left[1-\left(\frac{1+\pi_{it}}{1+r_t}\right)^{T+1}\right] / \left[1-\left(\frac{1+\pi_{it}}{1+r_t}\right)\right]$$

The anticipated costs c_t are to be minimized w.r.t. k_{it} and k_{It} subject to a production function describing the possible technologies for the new investments. The specification of the production function has been the subject of quite intensive research and a number of alternatives have been tested. For the Danish model the first specification tested was a four factor Mukerji/CRESH-production function proposed by Hanoch (1971). This function is homothetic, has constant ratios of substitution elasticities and allows different elasticities between any pairs of factors. Following the formulation by Mukerji (1963) the production function may be defined implicitly on the unitary production curve as

$$\text{eq. 3.11.} \quad F(y,\bar{x}) = \left[\sum_{i=1}^{n} D_i \left(\frac{x_i}{h(y)}\right)^{-d_i}\right]^{-1/d} - 1 \equiv 0$$

for factor inputs $x_i > 0$, output y in the range $0 < y < \bar{y} < \infty$ where $\bar{y}$ denotes the maximum producible output, and where h(y) is a continuously differentiable function of output with $h(0) = 0$, $h(\bar{y}) = \infty$ and $h'(y) > 0$. The parameters of the function are D_i, d_i and d where d is not determined and may be fixed at unity.

For eq. 3.11 to qualify as a well-behaved production function the parameters have to satisfy the restrictions (see Hanoch (1971) p. 697 and 700):

max $D_i > 0$ and

D_i and d_i are of the same sign for all i

Further, for the equation to be valid globally we have that

$d_i > -1$ for all i

however, in a restricted domain of the equation one d_i is allowed to be less than -1.

Assuming constant returns to scale and incorporating disembodied factor-augmenting technical changes eq. 3.11 may be reformulated as

$$\text{eq. 3.12.} \quad F(y,\bar{x},t) = \Big[\sum_{i=1}^{n} D_i \big[(1+g_i)^t \Big(\frac{x_i}{y}\Big)\big]^{-d_i}\Big]^{-1/d} - 1 \equiv 0$$

or

$$\text{eq. 3.13.} \quad F(\bar{k},t) = \Big[\sum_{i=1}^{n} D_i \big[(1+g_i)^t k_i\big]^{-d_i}\Big]^{-1/d} - 1 \equiv 0$$

If the technical changes are Hicks-neutral the g_i's are all equal. Now minimizing the cost-function eq. 3.9 subject to eq. 3.13 one may derive the following set of equations for the technical coefficients (see MS.11 Appendix C)

$$\text{eq. 3.14.} \quad \log k_{it} = \frac{1}{(1+d_i)} \log D_i d_i - \frac{1}{(1+d_i)} \log P_{it} - \frac{d_i}{(1+d_i)} t \log (1+g_i) + \frac{1}{(1+d_i)} \log \lambda$$

$$i = 1 \ldots n$$

where P_{it} is the anticipated prices p_{it} Π_{it} and PI_t and where $D_i d_i > 0$, $d_i > -1$ and λ is the Langrangean parameter from the minimization problem given by

$$\text{eq. 3.15.} \quad \lambda = \sum_{i=1}^{n} \frac{P_i k_i}{d_i} > 0$$

from which we have that $d_i \neq 0$ and at least one $d_i > 0$. Inserting eq. 3.15 into eq. 3.14 the equations become highly non-linear and rather difficult to estimate. Further for all practical purposes eq. 3.15 requires that all $d_i >> 0$ because when one d_i approaches zero and perhaps becomes negative the system becomes very unstable.

Assuming Hicks-neutral technical changes, that is the g_i's are all equal, a simultaneous estimation of the equations for capital, labour, energy and other intermediary inputs specified from eq. 3.14 and eq. 3.15 has been tried, however, the estimation produced serious convergency problems with some of the d_i's approaching zero and further the restriction $D_i d_i > 0$ for all i was violated. As an alternative the following iterative three-step procedure was tried:

step 1. Calculate λ using previous estimates of the d_i's

step 2. Estimate the D_i's and r with fixed values of λ and the d_i's

step 3. Estimate the d_i's with fixed values of λ, the D_i's and r

The three steps are repeated until convergence is obtained. The problem with this procedure is that it does not secure unbiased estimates, and the practical experiments with the procedure showed that a relative convergence was obtained after 3 to 5 iterations, but if the iterations were continued the log-likelihood value increased slightly with changing parameter values improving the fit of some of the equations at the expense of the fit of the other equations. Especially the equations for other intermediary inputs and energy came out with very low R^2-values and the Mukerji/CRESH production function was rejected. The problem seemed to be that the function was too flexible and that too many parameters had to be estimated. Therefore in a second set of experiments the production technology was described by the less flexible two-level Cobb-Douglas/CES production function.

Grouping the four production factors into two baskets with capital and energy in one basket and labour and other intermediary inputs in the other the two-level CD/CES production function defined on the unit production curve may be written as:

eq. 3.16. $$F(\bar{k},t) = Ae^{gt}\,[\alpha k_I^{-\delta} + (1-\alpha)k_E^{-\delta}]^{-\phi/\delta}$$

$$[\gamma k_L^{-\eta} + (1-\gamma)k_M^{-\eta}]^{-(1-\phi)/\eta} \equiv 1$$

where $k_i, i = I,E,L,M$ are the technical coefficients for capital, energy, labour and other intermediary inputs respectively. $A, g, \alpha, \delta, \phi, \gamma$ and η are parameters of the function. For eq. 3.16 to qualify as a well-behaved production function the parameters have to satisfy the restrictions

$$0 < \alpha, \gamma, \phi, < 1 \; ; \; \delta, \eta > -1 \text{ and } A > 0$$

By specifying the production function of eq. 3.16 it is assumed that the two baskets are strongly separable with an elasticity of substitution between the two baskets equal to one. Further it is assumed that the technical changes are Hicks-neutral with g being the rate of technical progress.

Minimizing the cost-function eq. 3.9 subject to eq. 3.16 the following set of equations for the marginal technical coefficients may be derived (see MS. 17 p. 14-15) eq. 3.17. $\log k_E = \sigma \log \alpha_1 + \sigma \log(p_I/p_E) + \log k_I$

$$\log k_M = \sigma_2 \log \gamma_1 + \sigma_2 \log(p_L/p_M) + \log k_L$$

$$\log k_I = \log(\frac{\phi}{1-\phi}) + \log(p_L/p_E)$$

$$- \log(1+\alpha_1^{\sigma}(p_I/p_E)^{(\sigma-1)})$$

$$+ \log(1-\gamma_1^{\sigma_2}(p_L/p_M)^{(\sigma_2-1)}) + \log k_L$$

$$\log k_L = - \log A - gt +$$

$$\log\left[(1+\alpha_1)^{(\frac{\phi\sigma}{\sigma-1})}(1+\gamma_1)^{(\frac{(1-\phi)\sigma_2}{\sigma_2-1})}(\frac{\phi}{1-\phi})^{-\phi}\right]$$

$$- \phi \log(p_L/p_I) + \frac{\phi}{1-\sigma} \log\left[1-\alpha_1^{\sigma}(p_I/p_E)^{(\sigma-1)}\right]$$

$$+ \frac{\sigma_2-\phi}{1-\sigma_2} \log\left[1+\gamma_1^{\sigma_2}(p_L/p_M)^{(\sigma_2-1)}\right]$$

where $\alpha_1 = \frac{1-\alpha}{\alpha}$; $\gamma_1 = \frac{1-\gamma}{\gamma}$, $\sigma = \frac{1}{1+\delta}$ and $\sigma_2 = \frac{1}{1+\eta}$

When estimating the four equations simultaneously there are serious convergence problems as over the iterations the parameters σ, α_1 and σ, γ_1 tend to vary together pairwise. Therefore to obtain reasonable and interpretable estimates the following two-step procedure was used:

Step 1. Estimate the parameters A, r, δ, ϕ and η with α_1 and γ_1 fixed at some reasonable values. The values chosen for α and γ are

$$\alpha = \frac{\hat{k}_I}{(\hat{k}_I + \hat{k}_E)} \quad \text{and} \quad \gamma = \frac{\hat{k}_L}{(\hat{k}_L + \hat{k}_M)}$$

where $\hat{k}_i$ is the average of k_i over the estimation period. From these values the start values for α_1 and γ_1 are calculated according to the definitions.

Step 2. Estimate α_1 and γ_1 conditioned to the first step estimates of A, r, δ, ϕ and η .

It should be noticed that these conditioned estimations may produce biased estimates and the actual estimations performed for the industrial branches do indicate that this might be a real problem. Although the estimated parameters are highly significant and have reasonable values the fit of the equations is extremely poor (R^2-values often below 0.1) and there seems to be considerable positive auto-correlation problems, that is either the model is seriously misspecified or the estimation method produces biased estimates.

As there appears to be serious problems with the implementation of both the four factor Mukerji/CRESH production function and the nested four factor two-level CD/CES production function a third experiment with a three factor CD/CES production function has been performed. This production function has proven to give acceptable results for the French model. The estimation of the three factor CD/CES-production function has been carried out by the central team of the HERMES project and the results are the production block presently incorporated into the Danish model.

The factor excluded from the production function is the other intermediary input and we have a production function in capital, labour and energy. In this function the factors capital and energy are grouped together into a composite factor and the substitution between capital and energy is described by a CES production function while the substitution between the composite factor and labour is described by a CD production function, that is we assume strong separability between the composite factor and labour. Defined on the unit production curve this function may be written as

eq. 3.18. $F(\bar{k},t) =$

$$Ae^{gt}(\alpha k_{It}^{-\delta}+(1-\alpha)k_{Et}^{-\delta})^{-\phi/\delta}\, k_{Lt}^{(1-\phi)} = 1$$

where the Allen elasticities of substitution are:

$$\eta_{IL} = \eta_{EL} = 1 \qquad \text{and}$$

$$\eta_{IE} = \frac{\left(\frac{1}{1+\delta}\right)-(1-\phi)}{\phi}$$

Deleting the costs of other intermediary inputs from the cost function the optimization problem of the procedures becomes:

eq. 3.19. $\min.\ c_t = p_{It}k_{It} + p_{Lt}k_{Lt} + p_{Et}k_{Et}$

w.r.t. k_{It}, k_{tI}, k_{Et}

subj. to $F(\bar{k},t) =$

$$Ae^{gt}(\alpha k_{It}^{-\delta} +(1-\alpha)k_{Et}^{-\delta})^{-\phi/\delta}\, k_{Lt}^{(1-\phi)}$$

The solution to this problem is derived from the Langrangean function eq. 3.20. $\Gamma = P_I\ k_I + P_L k_L + P_E k_E + \lambda(F(\bar{K}^*, t)-1)$

where the t subscript is omitted.

The first order conditions for the optimum are

eq. 3.21. $$\frac{\delta\Gamma}{\delta k_I} = P_I + \lambda F_I = 0$$

$$\frac{\delta\Gamma}{\delta k_E} = P_E + \lambda F_E = 0$$

$$\frac{\delta\Gamma}{\delta k_L} = P_L + \lambda F_L = 0$$

and $$F(\bar{K}^*, t) = 1$$

where $$F_I = \frac{\delta F(\bar{K}^*, t)}{\delta k_I}$$

$$F_E = \frac{\delta F(\bar{K}^*, t)}{\delta k_E}$$

$$F_L = \frac{\delta F(\bar{K}^*, t)}{\delta k_L}$$

and $\bar{K}^*$ is a vector of optimum factor for demands. To simplify the notation the asterix characterizing the optimum values will hereafter be omitted.

Now differentiating the production function we have

eq. 3.22. $$F_I = \frac{\delta F(\bar{K}, t)}{\delta k_I}. = Ae^{gt}\left(-\frac{\phi}{\delta}\right)(\alpha k_I^{-\delta}+(1-\alpha)k_E^{-\delta})^{-(\phi/\delta)-1}$$

$$(-\alpha\delta k_I^{-\delta-1})k_L^{(1-\phi)} = \frac{\phi\alpha k_I^{-\delta-1}\ F(\bar{K}, t)}{\alpha k_I^{-\delta}+(1-\alpha)k_E^{-\delta}}$$

$$F_E = \frac{\delta F(\bar{K},t)}{\delta K_E} = Ae^{gt}(-\frac{\phi}{\delta})(\alpha k_I^{-\delta}+(1-\alpha)k_E^{-\delta})^{-(\phi/\delta)-1}$$

$$(1-\alpha)(-\delta)k_E^{-\delta-1}\ k_L^{(1-\phi)}$$

$$= \frac{\phi(1-\alpha)k_E^{-\delta-1}\ F(\bar{K},t)}{\alpha k_I^{-\delta}+(1-\alpha)k_E^{-\delta}}$$

$$F_L = \frac{\delta F(\bar{K},t)}{\delta k_L} = Ae^{gt}(\alpha k_{It}^{-\delta}+(1-\alpha)k_{Et}^{-\delta})^{-\phi/\delta}$$

$$(1-\phi)k_L^{-\phi}$$

$$= \frac{(1-\phi)F(\bar{K},t)}{k_L}$$

Now combining the first two first-order conditions (eq. 3.21) we have

eq. 3.23. $$\frac{p_E}{p_I} = \frac{F_E}{F_I} = \frac{\dfrac{\phi(1-\alpha)k_E^{-\delta-1}\ F(\bar{K},t)}{\alpha k_I^{-\delta} + (1-\alpha)\ k_E^{-\delta}}}{\dfrac{\phi\alpha k_I^{-\delta-1}\ F(\bar{K},t)}{\alpha k_I^{-\delta} + (1-\alpha)k_E^{-\delta}}}$$

$$= \frac{\phi(1-\alpha)k_E^{-\delta-1}}{\phi\alpha k_I^{-\delta-1}} = \frac{(1-\alpha)k_E^{-\delta-1}}{\alpha k_I^{-\delta-1}}$$

To simplify we define as $\sigma = \frac{1}{1+\delta}$ and $a = \frac{(1-\alpha)}{\alpha}$

and eq. 3.23 may be written as

$$a\left(\frac{k_E}{k_I}\right)^{-1/\sigma} = \frac{P_E}{P_I}$$

so that

$$\text{eq. 3.24.}\quad \frac{k_E}{k_I} = a^{\sigma}\left(\frac{P_I}{P_E}\right)^{\sigma} = b\left(\frac{P_I}{P_E}\right)^{\sigma}$$

where $b = a^{\sigma}$

Using the result and dividing the numerator and the denominator of F_I by $\alpha k_I^{-\delta}$ we obtain

$$\text{eq. 3.25.}\quad F_I = \frac{\phi k_I^{-1} F(k,t)}{1 + \frac{(1-\alpha)}{\alpha}\left(\frac{k_E}{k_I}\right)^{-\delta}} = \frac{\phi k_I^{-1} F(k,t)}{1 + a\left(a^{\sigma}\left(\frac{P_I}{P_E}\right)^{\sigma}\right)^{-\delta}}$$

$$= \frac{\phi}{1 + a^{(1-\sigma\delta)}\left(\frac{P_I}{P_E}\right)^{-\sigma\delta}} \quad \frac{F(\bar{k},t)}{k_I}$$

or since $b = a^{\sigma}$ and $\sigma = \frac{1}{1+\delta}$ $\quad \sigma\delta = 1-\sigma$

$$\text{eq. 3.26.}\quad F_I = \frac{\phi}{1 + b\left(\frac{P_I}{P_E}\right)^{\sigma-1}} \quad \frac{F(\bar{k},t)}{k_I}$$

Similarly for F_E we obtain

$$\text{eq. 3.27.}\quad F_E = \frac{\phi \frac{(1-\alpha)}{\alpha}\left(\frac{k_E}{k_I}\right)^{-\delta}}{1 + \frac{(1-\alpha)}{\alpha}\left(\frac{k_E}{k_I}\right)^{-\delta}} \quad \frac{F(\bar{k},t)}{k_E}$$

Since from eq. 3.25 and 3.26 we have that

$$\frac{1-\alpha}{\alpha}\left(\frac{k_E}{k_I}\right)^{-\delta} = a\left(a^{\sigma}\left(\frac{P_I}{P_E}\right)^{\sigma}\right)^{-\delta} = b\left(\frac{P_I}{P_E}\right)^{\sigma-1}$$

eq. 3.27 may be reformulated as

$$\text{eq. 3.28.}\quad F_E = \frac{\phi b\left(\frac{P_I}{P_E}\right)^{\sigma-1}}{1+b\left(\frac{P_I}{P_E}\right)^{\sigma-1}}\;\frac{F(\bar{K},t)}{k_E} = \frac{\phi b}{\left(\frac{P_E}{P_I}\right)^{\sigma-1}+b}\;\frac{F(\bar{K},t)}{k_E}$$

Now combining the first-order conditions for capital and labour and using eq. 3.22 and 3.26 we have

$$\frac{P_I}{P_L} = \frac{F_I}{F_L} = \frac{\dfrac{\phi}{1+b\left(\frac{P_I}{P_E}\right)^{\sigma-1}}\;\dfrac{F(\bar{K},t)}{k_I}}{(1-\phi)\;\dfrac{F(\bar{K},t)}{k_L}}$$

$$= \frac{\phi}{(1-\phi)\left(1+b\left(\frac{P_I}{P_E}\right)^{\sigma-1}\right)}\;\frac{k_L}{k_I}$$

or

$$\text{eq. 3.29.}\quad \frac{k_L}{k_I} = \frac{(1-\phi)}{\phi}\left(1+b\left(\frac{P_I}{P_E}\right)^{\sigma-1}\right)\left(\frac{P_I}{P_L}\right)$$

Rearranging the production function and dividing by k_I we have

$$\text{eq. 3.30.}\quad k_I = \frac{e^{-gt}}{A}\,\alpha^{\phi/\delta}\,\left(1+\frac{1-\alpha}{\alpha}\left(\frac{k_E}{k_I}\right)^{-\delta}\right)^{\phi/\delta}\left(\frac{k_L}{k_I}\right)^{\phi-1}$$

Inserting eq. 3.24 and eq. 3.29 into eq. 3.30 we obtain

$$\text{eq. 3.31.}\quad k_I = \frac{e^{-gt}}{A}\,\alpha^{\phi/\delta}\left(1+b\left(\frac{p_I}{p_E}\right)^{\sigma-1}\right)^{\phi/\delta}\left(\frac{1-\phi}{\phi}\right)^{\phi-1}$$

$$\left(1+b\left(\frac{p_I}{p_E}\right)^{\sigma-1}\right)^{\phi-1}\left(\frac{p_I}{p_L}\right)^{\phi-1}$$

which may be reduced to

$$\text{eq. 3.32.}\quad k_I = c_I e^{-gt}\left(1+b\left(\frac{p_E}{p_I}\right)^{1-\sigma}\right)^{\frac{\phi}{1-\sigma}-1}\left(\frac{p_L}{p_I}\right)^{1-\phi}$$

where $c_I = \frac{1}{A}\,\alpha^{\phi/\delta}\left(\frac{1-\phi}{\phi}\right)^{\phi-1}$ and where we have used

that $\sigma = \frac{1}{1+\delta}$,

that is $\phi/\delta + \phi - 1 = \phi(1+\frac{1}{\delta})-1 = \phi(\frac{\delta+1}{\delta})-1 = \phi(\sigma\delta)^{-1}-1$

$$= \phi(1-\sigma)^{-1}-1$$

The marginal technical coefficient for the labour and energy inputs are derived from the definitions

$$\text{eq. 3.33.}\quad k_L = \left(\frac{k_L}{k_I}\right) k_I \quad \text{and} \quad \text{eq. 3.34.}\quad k_E = \left(\frac{k_E}{k_I}\right) k_I$$

Inserting the equations 3.29 and 3.32 into eq. 3.33 gives

$$\text{eq. 3.34}\quad k_L = \left(\frac{1-\phi}{\phi}\right)\left(1+b\left(\frac{P_I}{P_E}\right)^{\sigma-1}\right)\left(\frac{P_I}{P_L}\right)$$

$$c_I\, e^{-gt}\left(1+b\left(\frac{P_E}{P_I}\right)^{1-\sigma}\right)^{\frac{\phi}{1-\sigma}-1}\left(\frac{P_L}{P_I}\right)^{1-\phi}$$

which may by reduced to

$$\text{eq. 3.35.}\quad k_L = c_I\left(\frac{1-\phi}{\phi}\right) e^{-gt}\left(1+b\left(\frac{P_E}{P_I}\right)^{1-\sigma}\right)^{\frac{\phi}{1-\sigma}}\left(\frac{P_I}{P_L}\right)^{\phi}$$

and inserting the equations 3.24 and 3.32 into eq.3.34 we obtain

$$k_E = b\left(\frac{P_I}{P_E}\right)^{\sigma} c_I\, e^{-gt}\left(1+b\left(\frac{P_E}{P_I}\right)^{1-\sigma}\right)^{\frac{\phi}{1-\sigma}-1}\left(\frac{P_L}{P_I}\right)^{1-\phi}$$

which may be written as

$$\text{eq. 3.36.}\quad k_E = c_I b\, e^{-gt}\left(1+b\left(\frac{P_I}{P_E}\right)^{\sigma-1}\right)^{\frac{\phi}{1-\sigma}-1}$$

$$\left(\frac{P_I}{P_L}\right)^{\phi-1}\left(\frac{P_E}{P_I}\right)^{\phi-1}\left(\frac{P_I}{P_E}\right)^{\phi-1+\sigma}$$

now using that

$$\left(\frac{P_I}{P_E}\right)^{\phi-1+\sigma} = \left(\left(\frac{P_I}{P_E}\right)^{1-\sigma}\right)^{\frac{\phi}{1-\sigma}-1}$$

and $$\left(\frac{p_I}{p_L}\right)^{\phi-1} \left(\frac{p_E}{p_I}\right)^{\phi-1} = \left(\frac{p_E}{p_L}\right)^{\phi-1}$$

equation 3.36 may be reformulated as

$$\text{eq. 3.37.}\quad k_E = c_I b\, e^{-gt} \left(b+\left(\frac{p_I}{p_E}\right)^{1-\sigma}\right)^{\frac{\phi}{1-\sigma}-1} \left(\frac{p_E}{p_L}\right)^{\phi-1}$$

In line with the first two experiments concerning the Mukerji/ CRESH and the nested four factor CD/CES production function it is possible to perform a simultaneous estimation of the equations 3.32, 3.35 and 3.37, however in this experiment it has been preferred to develop the equation for k_I into an investment equation which is estimated by a single equation estimation method while the factor demand for labour and energy is deduced from their optimum demand. The advantage of this method is that the dependent variable in the equation that is estimated is an observable variable, while the variables k_I, k_L and k_E are rather constructed variables. The drawbacks are that the economic theory suggests that the three equations for k_I, k_L and k_E should be estimated simultanously and that quite a number of parameters have to be revealed by estimating only one equation, the investment equation.

Looking at k_I it expresses the optimal investments per unit of new production capacity, that is

$$k_I = \frac{I^*}{Q^a}$$

where I^* is the optimal investments and Q^a is the anticipated new production capacity. In order to formulate an investment equation we therefore have to specify the transition from the optimal investments to the actual investments and how to calculate the anticipated new production capacity. To describe the transition from optimal to actual investments the geometric adjustment is adopted, that is

eq. 3.38. $$\frac{I_t}{I_{t-1}} = \left(\frac{I_t^*}{I_{t-1}}\right)^{\lambda}$$

where I_t is the actual investments in period t, I_t^* is the optimal investment and λ is the adjustment rate.

The anticipated new production capacity Q_t^a is calculated from the present and past actual production Y_t according to the following process

eq. 3.39. $$Q_t^a = \sum_{j=0}^{m} a_j \; (Y_{t-j} - (1-d)\; Y_{t-j-1})$$

where d is the scrapping rate, which for lack of actual observations is fixed at 0.1, and m is fixed at 2, that is Q_t^a is a three period weighted average with the weights adding to unity.

Now by logarithmic transformation of eq. 3.38 we have the following investment equation that is estimated for the industrial branches:

eq. 3.40. $$\log I_t = (1-\lambda) \log I_{t-1} + \lambda \left(\log \frac{I^*}{Q_t^a} + \log Q_t^a\right)$$

or $$\log I_t = (1-\lambda) \log I_{t-1} + \lambda\; (\log k_I + \log Q_t^a)$$

where $$k_I = c_I \, e^{-gt} \left(1+b\left(\frac{P_E}{P_I}\right)^{1-\sigma}\right)^{\frac{\phi}{1-\sigma}-1} \left(\frac{P_L}{P_I}\right)^{1-\phi}$$

and $$Q_t^a = a_0(Y_t-(1-d)Y_{t-1}) + a_1(Y_{t-1}-(1-d)Y_{t-1})$$

$$+ (1-a_0-a_1)\ (Y_{t-2}-(1-d)Y_{t-3})$$

Having estimated eq. 3.40 and assuming an equal scrapping rate for the labour and energy demand as for the investments, the optimal total demand for labour and energy are calculated as

eq. 3.41. $$L_t^* = (1-d)\ L_{t-1}^* + I_t \frac{k_{Lt}}{k_{It}}$$ and

eq. 3.42. $$E_t^* = (1-d)\ E_{t-1}^* + I_t \frac{k_{Et}}{k_{It}}$$

These demands correspond to the full capacity utilization, however as the actual demand depends on the desired input on the capacity used desired inputs are calculated

as $L_t^{**} = QR_t * L_t^*$ and $E_t^{**} = QR_t * E_t^*$

where QR_t is the capacity utilization rate.

The actual demand is finally obtained from the desired demand by the error - correction - mechanism:

eq. 3.43. $$\frac{L_t}{L_{t-1}} = \left(\frac{L_t^{**}}{L_{t-1}^{**}}\right)^{\lambda} \left(\frac{L_{t-1}^{**}}{L_{t-1}}\right)^{\mu}$$ and

$$\text{eq. } 3.44.\quad \frac{E_t}{E_{t-1}} = \left(\frac{E^{**}_t}{E^{**}_{t-1}}\right)^{\lambda} \left(\frac{E^{**}_{t-1}}{E_{t-1}}\right)^{\mu}$$

The production capacity by the branch is determined by

$$\text{eq. } 3.45.\quad QP_t = (1-d)\; QP_{t-1} + I_t * k^{-1}_{It}$$

and the capacity utilization rate is calculated as

$$\text{eq. } 3.46.\quad QR_t = Y_t/QP_t$$

Now looking at the estimation results the results for the investment equation are shown in table 3.2. Looking at the results it is noticed that a number of dummy-variables have been introduced and that the coefficients to these (called ct; t = 70, 71, 72, 74 and 76, where t is the year the dummy-variable is in action) are highly significant, that is the investments undergo significant changes that are not explained by the general equation 3.40. Further it is noticed, that in order to obtain reasonable estimates the b coefficient has been fixed in the final estimation and for branch C the adjustment coefficient λ is fixed at 1, that is there is no adjustment lag. Otherwise the estimated coefficients are reasonable and significant and the R^2-values are quite acceptable. From the substitution elasticities we observe that for the branches Q and K capital and energy are substitutes while for branch C we have complementarity between capital and energy.

Looking at the estimation results for the energy demand equations given in table 3.3 again it is noticed that a number of significant dummy-variables have been included. Otherwise the coefficients are reasonable and significant and the R^2-values are acceptable.

Table 3.2. Estimation results for the investment equation (eq. 3.40)

Branch	Q	K	C
$\log c_I$	-2.993 (-9.37)	-1.519 (-9.50)	-1.714 (-27.32)
g	0.0014 (11.87)	0.01 (-)	0.0016 (8.63)
b	0.9 (-)	1.0 (-)	1.0 (-)
σ	0.847 (25.89)	0.325 (4.52)	0.424 (12.29)
ϕ	0.399 (14.93)	0.794 (10.45)	0.445 (9.19)
λ	1.088 (38.53)	0.802 (17.72)	1.0 (-)
a_0	0.466 (54.37)	0.398 (12.37)	0.304 (11.33)
a_1	0.291 (44.92)	0.414 (13.15)	0.277 (13.85)
c70	0.199 (13.91)	-	-
c71	0.146 (19.99)	-0.110 (-3.86)	-
c72	-	-0.240 (-9.19)	-0.158 (11.12)
c74	-	-	0.412 (8.63)
c76	-	0.246 (3.87)	-
R^2	0.998	0.997	0.990
DW	2.39	2.12	1.86
η_{IE}	0.62	0.15	-0.29

t-values in brankets, if the parameter is fixed in the estimation the t-value is replaced by (-).

Table 3.3. Estimation results for the energy demand

$$\log (E_t) = c_t * D_t + \varepsilon + \lambda \, \Delta\log (E^{**}_{t-1}) + \mu (\log (E^{**}_{t-1}) - \log (E_{t-1}))$$

Branch	Q	K	C
ε	0.0018 (12.84)	-0.132 (-3.75)	-0.0073 (-10.56)
λ	0.344 (31.76)	0.573 (5.19)	0.284 (11.93)
μ	0.370 (16.61)	0.171 (5.67)	0.174 (13.47)
C_{73}	-	-	-0.0047 (-8.01)
C_{74}	-	-0.173 (-7.99)	-
C_{75}	-	0.0070 (2.70)	-
C_{76}	0.0063 (8.62)	-	-
C_{77}	-	-0.156 (-8.47)	-
C_{78}	-0.174 (-25.40)	0.0045 (2.44)	-
C_{79}	-0.0073 (-8.03)	-	-0.0069 (-10.79)
AR1*	-1.026 (-9.92)	1.0 (-)	0.0057 (0.95)
R^2	0.998	0.992	0.985
DW	2.54	1.62	2.01

* coefficient in a 1.order autoregressive estimation
t-values in brackets

Now coming to the demand for labour the estimation results for eq. 3.43 were not quite acceptable as for all the branches the μ coefficient had to be fixed in the estimation and as the equations produced unacceptable results when simulated outside the estimation period. In the present version of the model the employment equations are therefore given the following simple ad hoc specification

eq. 3.47. $\log(L_t) = a_0 + a_1 \log(Y_t) + a_2 * T$

where Y_t is the actual production and T is a trend.

As is seen from the estimation results given in Table 3.4 we still have some problems with the employment equation for branch C, however the equations give acceptable results in ex-post simulations.

Table 3.4. Estimation results for the employment equations eq. 3.47

Branch	Q	K	C
a_0	3.100 (1.67)	5.097 (2.90)	2.736 (7.61)
a_1	1.021 (4.74)	0.767 (3.52)	1.0 (-)
a_2	-0.026 (-6.16)	-0.011 (-1.68)	-0.020 (-4.51)
R^2	0.81	0.80	0.67
DW	1.12	1.40	0.32

t-values in brackets estimation period 1975-86

Concerning the fourth factor, the other intermediary inputs which is excluded from the production function, the demand for this factor is specified as dependent of the actual production, the price of the factor relative to the output-price of the branch and the capacity utilization rate of the branch. The equation is specified in logarithms, that is we have

$$\text{eq. 3.48.} \quad \log(M_t) = a_o + a_1\log(Y_t) + a_2\log(P_t^M/P_t^Y) + a_3\log(QR_t)$$

where M_t is the demand for intermediary inputs, Y_t is the actual production P_t^M is the price of intermediary inputs, P_t^Y the output-price and QR_t is the capacity utilization rate, a_o, a_1, a_2 and a_3 are parameters of the equation and should satisfy $a_1>o$ $a_2<o$ and $a_3>o$, that is the intermediary input should increase with production, decrease with increasing relative input prices and increase with the capacity utilization rate. This implies that the demand for intermediary inputs increase per unit of output as more output is produced on an unchanged production capacity. Looking at the estimation results given in table 3.5 it is seen that the coefficients are reasonable and significant, (satisfy the restrictions), and that the R^2-values and Durbin-Watson statistics are quite acceptable, that is these equations seem to raise no problems.

Concluding on the production block for the industrial branches quite some effort has been put into developing a reasonable four factor putty-clay description of the production process. Unfortunately much of the research has not been very successful. In order to obtain a workable model the flexible four factor putty-clay production function has been modified to a fairly restrictive three factor

Table 3.5. Estimation results for the demand for other intermediary inputs eq. 3.48

Branch	Q	K	C
a_0	0.222 (0.28)	-1.167 (-2.23)	-0.950 (-2.87)
a_1	0.916 (11.41)	1.055 (20.56)	1.054 (35.18)
a_2	-0.209 (-0.90)	-0.339 (-1.86)	-0.524 (-2.03)
a_3	0.066 (0.60)	0.207 (2.08)	0.123 (1.81)
a^2	0.96	0.98	0.99
DW	2.36	1.69	2.03

t-values in brackets estimation period 1969-83

putty-clay production function and even this set-up is hardly workable as it produces very poor forecasts for the employment. The employment equations included in the present version of the model are therefore decoupled from the production function and are given simple ad hoc specifications. One can hardly say that we have obtained a reasonable putty-clay description of the production process, to obtain that further research is needed, however the model gives reasonable simulation results.

3.4. The factor demand equations for the non-industrial branches

For the non-industrial branches of the model the factor demand equations are given simple ad hoc specifications. In general the demand for a factor is specified as dependent of the output by the branch, the factor price, a trend, lagged values of the dependent variable and when necessary dummy-variables. The demand for capital, that is the investment equations are specified as

eq. 3.49. $\log(I_t) = a_o+a_1\log(Y_t)+a_2\log(P_t^I)+a_3\log(I_{t-1})$

$+a_4\text{Dummy}$

when I_t is the investments by the branch, Y_t is the output and P_t^I is the price of the investments.

Similarly the demand for labour, that is the employment equations are specified as

eq. 3.50. $\log(L_t) = a_o+a_1\log(Y_t)+a_2T+a_3\text{Dummy}$

where L_t is employment by the branch and T is a trend. In the estimations the inclusion of a wage index has been tested, however this variable was not significant and is therefore excluded from the equations included in the present version of the model.

The demand for energy is specified as

eq. 3.51. $\log(E_t) = a_o+a_1\log(Y_t)+a_2\log(P_t^E)+a_3T+a_4\text{Dummy}$

where E_t is the energy consumption of the branch and P_t^E is the energy price. Finally, the demand for other intermediary inputs is specified simply as

eq. 3.52. $\log(M_t) = a_o+a_1\log(Y_t)+a_2T$

The inclusion of a price index for the other intermediary inputs has been tested, but it was not significant in the estimations.

The estimation results for the factor demand equations are shown in the tables 3.6 to 3.9.

Looking at the estimation results for the investment equations a number of problems may be observed. For the agricultural branch A neither the production nor the price of investments explains the development of the investments, however with a R^2 of 0.9 the investments are explained by a constant and two dummy-variables. Similarly for the energy branch E neither the production nor the investment price is significant and the investments are mainly explained by lagged investments and a dummy variable.

Table 3.6. Estimation results for the investment equations

$$\log(I_t) = a_0 + a_1 \log(Y_t) + a_2 \log(P_t^I) + a_3 \log(I_{t-1}) + a_4 \text{ Dummy}$$

Branch	a_0	a_1	a_2	a_3	Dummies	R^2	DW
A	7.818 (225.83)	-	-	-	D7380;D7779	0.91	1.69
E	2.833 (0.74)	0.117 (0.27)	-0.008 (-0.06)	0.485 (2.25)	D8192	0.88	2.55
B	-1.553 (-0.52)	0.560 (1.67)	-	0.396 (1.79)	-	0.48	0.99
Z	5.144 (0.93)	0.333 (0.62)	-0.142 (-1.04)	-	D7678;D8282	0.65	1.78
L	-17.618 (-2.37)	2.292 (3.55)	-0.499 (-1.99)	-	D8182	0.84	1.63

Table 3.7. Estimation results for the employment equations

$\log(L_t) = a_o + a_1\log(Y_t) + a_2T + a_3\text{Dummy}$

Branch	a_o	a_1	a_2	Dummies	R^2	DW
A	9.810 (3.24)	0.175 (0.48)	-0.010 (-1.12)	D7982	0.87	2.45
E	8.817 (124.18)	-	0.011 (11.58)	D8082,D8388	0.98	2.24
B	2.932 (2.92)	0.902 (10.51)	-0.006 (-2.35)	-	0.95	1.48
Z	10.658 (32.07)	0.038 (1.40)	0.011 (12.41)	D8692	0.98	2.14
L	4.928 (7.48)	0.783 (11.45)	-0.010 (-5.65)	D8384	0.98	1.89

Table 3.8. Estimation results for the energy demand equations

$\log(E_t) = a_o + a_1\log(Y_t) + a_2\log(P_{Et}) + a_3T$

Branch	a_o	a_1	a_2	a_3	R^2	DW
A	35.164 (3.88)	1.00 -	-	-0.020 (-4.26)	0.53	0.64
E	59.020 (10.11)	1.568 (14.89)	-	-0.033 (-9.94)	0.94	1.11
B	1.076 (0.53)	0.427 (2.21)	-	-	0.23	1.01
Z	-24.861 (-1.86)	0.902 (2.56)	-	0.011 (1.34)	0.94	1.91
L	-9.377 (-2.43)	1.437 (4.28)	-0.171 (-2.74)	-	0.61	1.15
N	-16.415 (-5.88)	2.109 (8.30)	-0.223 (-3.13)	-	0.94	2.08

Table 3.9. Estimation results for the other intermediary inputs

$\log(M_t) = a_o + a_1\log(Y_t) + a_2T$

Branch	a_o	a_1	a_2	R^2	DW
A	-0.378 (-0.30)	0.970 (7.73)	-	0.79	1.64
E	-47.892 (-2.81)	0.047 (0.15)	0.028 (2.85)	0.56	1.97
B	-28.613 (-8.24)	1.129 (15.39)	0.013 (8.72)	0.94	1.58
Z	-43.513 (-4.53)	0.719 (2.83)	0.023 (3.75)	0.98	1.27
L	-1.169 (-2.12)	0.978 (20.33)	-	0.96	0.98
N	62.268 (5.13)	1.634 (9.88)	-0.036 (-5.06)	0.99	1.22

Looking at the estimation results for the employment equations again it is noticed that for the branches A and E the production is an insignificant explaining variable. For branch Z there are multicollinearity problems between the production and the trend and the coefficients are heavily dependent on the estimation period used. Looking at the estimation results for the energy equations it is noticed that for branch A the production coefficient is fixed á priori at 1.0 and looking at the estimation results for the other intermediary inputs it is noticed that for branch E the production coefficient is very little and insignificant. In general there appear to be problems with the factor demand equations for the branches A and E, and in a second version of the model further research may be put into the formulation of these equations.

4. PRICE AND WAGE EQUATIONS

4.1. Introduction

Based on the domestic producer's prices the model determines prices for the branches of the model and the components of demand via identities or quasi-identities, that is, besides the domestic producer's prices, which are determined by behavioural equations, the model determines prices for deliveries to intermediary consumption, final consumption of households, consumption of the general government and gross fixed capital formation. Exogenous to the national version of the model are the prices of imports and exports and the prices of types of fuels.

Wages are determined at the branch level. Among the specifications tested for the individual branches are equations incorporating elements of the Phillip's curve theory, the neoclassical wage theory and the theory of wage contagiousness between branches. Although it for most of the branches has been possible to obtain reasonable estimates of the tested equations, when these equations were incorporated into the model the simulation experiments became rather poor and difficult to interprete. Therefore in the present version of the model an equation determining the overall wage index has been introduced and for the individual branches wages are mainly determined by the overall wage index.

4.2. Price equations

The relations for the domestic producer's prices are based on the average cost pricing rule combined with the theory of price-taker behaviour on markets that are open to foreign competition. The domestic production costs (PB_i) represent the average costs per unit of output and are calculated as a weighted average of the prices of the input factors where the weights are the one year lagged factor shares. Following this set-up the output price for the individual branch is given the following simple specification:

eq. 4.1. $\log(PQF_i) = a_0+a_1\log(PB_i)+a_2\log(PQM_i)+a_3D$

where PQF_i is the output price, PB_i is the production costs, PQM_i is the import price and D is a dummy variable. Under ideal conditions a_0 and a_3 should equal zero, a_1 and a_2 should add to unity and the size of a_2 would be a measure of the degree of price-takership, however imposing these restrictions drastically reduces the explanatory power of eq. 4.1, that is the restrictions seem too strong.

Looking briefly at table 4.1 it is noticed that significant price-taker behaviour is present in the agricultural branch (the price is determined by the EEC price setting, in the model the export price is used as a proxy for this), the energy branch and the two industrial branches Q and K.

Table 4.1. Estimation results for the output-price equations

Branch	a_0	a_1	a_2	Dummies	R^2	DW
A	-0.023 (-2.92)	0.213 (1.84)	0.692 (6.18)	-	0.995	2.28
E	0.012 (0.96)	0.362 (2.13)	0.444 (3.14)	D8188	0.999	1.85
Q	0.031 (6.94)	0.772 (11.65)	0.145 (2.38)	D8288	0.999	1.21
K	-0.017 (-2.80)	0.597 (3.86)	0.451 (2.64)	-	0.998	1.46
C	0.007 (2.77)	1.010 (169.21)	-	-	0.999	1.55
B	-0.046 (-6.16)	0.945 (62.69)	-	D7575	0.996	1.41
Z	-0.011 (-2.31)	0.910 (104.10)	-	-	0.999	2.15
L	-0.014 (-2.20)	0.924 (15.08)	0.072 (1.10)	D8081	0.998	1.01
N	-0.014 (-3.54)	1.019 (122.75)	-	D8081	0.999	1.57

The other endogenous prices of the model are obtained by identity or quasi-identity and are determined by the domestic producer's prices and the relevant indirect taxes to go from basic to market prices. For the deliveries from branch i to intermediary consumption and to the consumption of the general government and to stocks no indirect taxes are added and the prices are defined equal to the domestic producer's prices, that is eq. 4.2. $PQQ_i = PQF_i$

eq. 4.3. $PQG_i = PQF_i$ and

eq. 4.4. $PQS_i = PQF_i$

where PQQ_i is the price of deliveries from branch i to intermediary consumption, PQG_i is the price of deliveries from branch i to the consumption of the general government and PQS_i is the price of deliveries from branch i to stocks.

For the different categories of consumer expenditures the prices are determined by

eq. 4.5. $$\Delta \log(PC_{ct}) = a_0 + a_1 \Delta \log(\sum_i cc_{ci} * PQF_{it}) + a_2 \Delta \left(\frac{1+ITCR_{ct}}{1+ITCR_c^{75}}\right)$$

or

$$\Delta (PC_{ct}) = a_0 + a_1 \Delta(\sum_i cc_{ci} * PQF_{it}) + a_2 \Delta \left(\frac{1+ITCR_{ct}}{1+ITCR_c^{75}}\right)$$

where PC_{ct} is the price of consumer category c, PQF_{it} is the domestic producer price for branch i, $ITCR_{ct}$ and $ITCR_c^{75}$ is the indirect tax-rate on consumer category c in period t and 1975 respectively and cc_{ci} is the 1975-coefficient matrix giving the share of each expenditure category delivered by the individual branches.

From these prices the price of deliveries from branch i to private household consumption is derived as eq. 4.6. $PQH_i = \sum_c cc_{ic}CU_c / \sum_c cc_{ic}\, CO_c = QHU_i/QHO_i$

where CU_c is the consumption of category c in current prices and CO_c is the consumption of category c in constant prices.

The price of gross fixed capital formation by investing branch is determined by

eq. 4.7. $\log(PIQ_{it}) = a_0+a_1*(\sum_j ci_{ij}\log(PQF_{jt}))*(\frac{1+ITIQR_t}{1+ITIQR^{75}})$

where $ITIQR_t$ and $ITIQR^{75}$ is the indirect tax-rate on investments in period t and 1975 respectively and ci_{ij} is the share of investments in branch i that is delivered by branch j.

From the investment prices the price of deliveries from branch i to gross fixed capital formation is determined by

eq. 4.8. $PQI_{it} = \sum_j ci_{ji}IU_j / \sum_j ci_{ji}IO_j = QIU_i/QIO_i$

where IU_j is the investments in branch j and dwelling in current prices and IO_j is the investments in branch j and dwellings in constant prices.

Finally, the price energy input used by branch i is determined by

eq. 4.9. $PQE_i = a_0+a_1(\sum_e SH_e*PEQ_e)$

where PEQ_e is the price of energy type e (which is exogenous) and SH_e is the share of energy type e out of the total energy budget, and the price of other intermediary inputs in branch i is determined by eq. 4.10. $PQO_i = a_0 + a_1 * (\sum_j cq_{ij} PQF_j / \sum_j cq_{ij})$

where cq_{ij} is the intermediary input in branch i delivered from branch j.

4.3. Wage equations

In determining the wage equation by branch the first specification tested incorporated elements of the Phillip's curve theory, the neoclassical theory of wage formations and the theory of wage-contagiousness between branches. Following the Phillip's curve theory real wages are mainly determined by the unemployment rate or nominal wages depend on the unemployment rate and the rate of inflation. Following the neoclassical theory in the long run changes in the real wage are dependent of productivity changes. The inclusion of productivity changes in the wage equations may also be argued from theories concerning wage negociations. Finally, the theory of wage-contagiousness between branches states that wage changes in different branches are interdependent. Now combining these theories the general equation that has been tested may be written as

eq. 4.11. $$\Delta\log(WR_{it}) = a_0 + a_1 UR_t + a_2 \left[(1-\phi)\Delta\log PCH_t + \phi\Delta\log PCH_{t-1}\right]$$
$$+K\left[\eta\log(QVO_{it}/N_{it}) + (1-\eta)\log(QVOT_t/NT_t)\right.$$
$$\left. -(\log WR_{it-1}/(\eta\log PQF_{it} + (1-\eta)\log PQFT_t))\right]$$

where WR_{it} is the wage rate of the branch, UR_t is the unemployment rate, PCH_t is the consumer price index, QVO_{it}/N_{it} and $QVOT_t/NT_t$ is the productivity of the branch and the total productivity respectively and PQF_{it} and $PQFT_t$ is the domestic producer's price of the branch and of the total production respectively.

When a_2 equals one we assume that in the long run wages are fully compensated for changes in the consumer prices, that is any trade-off between the rate of unemployment and the rate of inflation is only temporary. When η is not significant less than one the hypothesis of the wage-contagiousness between the branches may be rejected and when K is not significant different from zero the neoclassical wage theory is not accepted and the equation reduces to a Phillip's curve equation.

From estimation experiments imposing different combinations of restrictions on the parameters of eq. 4.11 it is concluded that

- when wage-contagiousness is defined as in eq. 4.11 it has not been possible to reveal significant wage-contagiousness in any of the branches.

- the inclusion of productivity changes and the neoclassical-oriented specification adds only marginally to the explanatory power of the Phillip's curve and these specifications often result in estimates that are difficult to interpret, that is in eq. 4.11 K should equal zero.

- the hypothesis of full compensation for increases in the consumer prices is not in general accepted, that is in general a_2 should be estimated and not just assumed equal to one.

From the estimation experiments we also have that the explanatory power and the size of the estimated coefficients of eq. 4.11 are for most of the branches quite acceptable, however when the equations are included in the model the simulation results are rather poor and quite difficult to interpret. Therefore in the present version of the model an equation for the overall wage rate has been introduced and the wage rates by branches are mainly explained by the overall wage rate.

The equation for the overall wage rate is specified as

$$\text{eq. } 4.12. \quad \Delta\log(WR_t) = a_0 + a_1\log\left(\frac{UR_t}{UR^{75}}\right) + (1-\phi)\Delta\log(PCH_t)$$

$$+\phi\Delta\log(PCH_{t-1})$$

that is it is assumed that wages are fully compensated for changes in the consumer prices and the unemployment rate is normalized to one in 1975. When tested for the overall wage rate the hypothesis of full compensation is not rejected, that is in eq. 4.11 a_2 is not significantly different from one, and the property that in the long run wages are fully compensated for price changes is an attractive property in a medium-term model.

The estimation result for eq. 4.12 is given by

$$\text{eq. } 4.13. \quad \Delta\log(WR_t) = \underset{(2.94)}{0.009} \underset{(-5.37)}{-0.022}\log\left(\frac{UR_t}{UR_{75}}\right) + \underset{(3.54)}{(1-0.592)}\Delta\log(PCH_t)$$

$$+\underset{(3.54)}{0.592}\ \Delta\log(PCH_{t-1})$$

$R^2 = 0.82$ DW = 2.26 (t-values in brackets) from which it is seen that changes in the unemployment rate have a quite significant effect on the changes in the wage rate, and that with an unchanged unemployment rate of UR_{75} in average the real wage rate will increase with about 0.9% per year.

For the individual branches the wage equations are given the following simple ad-hoc specification

eq. 4.14. $\log(WR_{it}) = a_0+a_1\log(WR_t)+a_2T$

where WR_{it} is the wage rate for branche i, WR_t is the overall wage rate and T is a trend.

Looking at the estimation results given in table 4.2 it is noticed that WR_t is the main explanatory variable and that the R^2 values are extremly high even taking into consideration that the equation is specified in totals and not first-differences, however the Durbin-Watson statistics are fairly low implying significant positive autocorrelation for most of the branches, that is eq. 4.14 seems to be too simple a specification and may be revised in the next version of the model.

Table 4.2. Estimation results for the wage equation (eq. 4.14)

Branch	a_0	a_1	a_2	R^2	DW
A	1.556 (0.81)	1.288 (7.08)	-0.016 (-0.84)	0.996	0.78
E	-0.411 (-0.32)	0.951 (8.03)	0.006 (0.50)	0.998	0.40
Q	0.860 (1.75)	1.078 (23.32)	-0.008 (-1.56)	0.999	1.09
K	2.531 (3.72)	1.256 (19.63)	-0.025 (-3.69)	0.999	1.11
C	4.117 (8.06)	1.441 (30.00)	-0.039 (-7.88)	0.999	0.71
B	-4.200 (-6.06)	0.529 (8.12)	0.040 (5.93)	0.999	0.83
Z	-1.124 (-1.97)	0.852 (15.87)	0.010 (1.78)	0.999	1.07
L	-0.409 (-1.13)	0.944 (27.79)	0.004 (1.00)	0.999	1.39
N	-0.694 (-1.01)	0.865 (13.34)	0.005 (0.70)	0.999	1.08

5. EXTERNAL TRADE

5.1. Introduction

The model treats the external trade at two levels; in the national models the aggregate imports and exports by branch are determined and in the linking of the national models (the link model) the bilateral trade flows are determined by a market clearing process. This section concentrates on the import and export equations that are endogenous in the national models. For a description of the bilateral flows and the interlinking of the national models the reader is referred to "The HERMES Model: Complete specification and first estimation results" published by the Commission of the European Communities (EUR 10669EN).

The estimated export equations are presented in section 5.2 and the determination of the imports is treated in section 5.3.

5.2. The export equations

For the individual branches of the model the export is specified as dependent of the output or production capacity of the branch, the price of the product on the export market and a trend, that is in general the specification is given by

eq. 5.1. $$\log(QXO_i) = a_0 + a_1\log(QFO_i) + a_2\log(PQF_i*EEXR) + a_3*trend + a_4*Dummy$$

where QXO_i is the export from branch i, QFO_i is the output, PQF_i is the output price and EEXR is an exchange rate index where the different currencies are weighted according to the Danish international trade. The exchange rate index expresses the number of foreign currencies per Danish crown, that is an increase in the index implies an appreciation of the Danish crown. The trend variable is included to capture the increasing international specialization and the expanding free trade world market and a number of dummy-variables are included to correct for sudden changes in the export volumes. The estimation results for eq. 5.1 are shown in table 5.1.

Looking at the estimation results a number of problems may be noticed. Looking at a_1, the coefficient to the production capacity or the proxy for this the output by the branch, the coefficient is positive and of reasonable size, but for the three industrial branches the coefficient is insignificant, that is for the three industrial branches it has not been possible to demonstrate a significant supply effect. In a number of alternative specifications supply effects via price responces have been tested, but the results have shown either insignificant coefficients or coefficients of wrong sign implying that the revealed effects are of a demand nature.

Looking at the price variable the formulation and the estimated coefficients imply a demand effect but again for most of the branches the coefficient is insignificant, and comparing with other national studies the price-elasticities are fairly low.

Finally, looking at the trend the estimated coefficients are positive and in general significant, that is the estimations show a significant expansion of the international trade.

Table 5.1. Estimation results for the export equations (eq. 5.1)

Branch	a_0	a_1	a_2	a_3	Dummies incl.	R^2	DW
A	-5.137 (-1,68)	1.296 (4.30)	-0.027 (-0.29)	0.0 -	D7174D77	0.95	2.56
E	-5.575 (-3.16)	1.0 -	-0.342 (-2.43)	0.049 (2.12)	D7276,D7881	0.80	2.51
Q*	-4.958 (-0.87)	0.821 (1.17)	-0.129 (-0.76)	0.071 (3.55)	-	0.99	2.15
K	-1.092 (-0.23)	0.803 (1.74)	-0.088 (-0.36)	0.030 (1.62)	-	0.91	0.93
C*	-3.051 (-0.52)	0.811 (1.38)	-0.347 (-4.01)	0.053 (4.66)	-	0.99	1.31
Z	-1.777 (-0.67)	1.007 (3.33)	0.0 -	0.008 (1.25)	D8392	0.95	2.08
L	-3.503 (-0.53)	0.793 (1.46)	-0.064 (-0.31)	0.039 (3.13)	D7077,D8392	0.99	1.82

(t-values in brackets)

* The output by the branch is replaced by the production capacity of the branch

Considering forecasts the trend appears fairly high, therefore when used for forecast simulations the trend is corrected downwards.

Concluding on the export equations, although the fit of the equations is acceptable, the picture is somewhat discouraging, and the equations of a preliminary nature. To obtain more reliable export equations for the next version of the model additional reasearch has to be put into the formulation and test of alternative specifications.

5.3. The determination of imports

The imports are determined at the branch level as imports from branches abroad that are similar to those defined for the domestic production. For each branch the imports are defined by quasi-identity as the part of total demand that is not satisfied by the domestic production and the import shares are determined by simple ad-hoc equations.

In chapter 3 equations 3.2-3.4 and figure 3.1 it was shown that deliveries from domestic branches are determined by the 1975 I/O-coefficients and the demands for different categories of uses. The share of deliveries coming from domestic producers were defined as:

deliveries to intermediary consumption $$cq_i^t = \frac{QQO_i^t}{QQO_i^t+MQO_i^t}$$

deliveries to private consumption $$ch_i^t = \frac{QHO_i^t}{QHO_i^t+MHO_i^t}$$

deliveries to investments $$ci_i^t = \frac{QIO_i^t}{QIO_i^t+MIO_i^t}$$

where QQO_i^t is the deliveries from the domestic branch i to the intermediary consumption.

MQO_i^t is the imports from branch i abroad to intermediary consumption.

QHO_i^t is the deliveries from the domestic branch i to private consumption.

MHO_i^t is the imports from branch i abroad to private consumption.

QIO_i^t is the deliveries from the domestic branch i to investments, and

MIO_i^t is the imports from branch i abroad to investments.

From these definitions the import from branch i abroad to intermediary consumption is determined by

$$\text{eq. 5.2.} \quad MQO_i^t = \frac{QQO_i^t}{cq_i^t} - QQO_i^t$$

and similarly the imports to private consumption and investments are determined by

$$\text{eq. 5.3.} \quad MHO_i^t = \frac{QHO_i^t}{ch_i^t} - QHO_i^t$$

and

$$\text{eq. 5.4.} \quad MIO_i^t = \frac{QIO_i^t}{ci_i^t} - QIO_i^t$$

From these definitions the total imports from branch i abroad are calculated as:

$$\text{eq. 5.5.} \quad QMO_i^t = MQO_i^t + MHO_i^t + MIO_i^t + MXO_i^t$$

where MXO_i^t is the import to export which is exogenous to the model.

The import shares are in the first version of the model simply explained by a trend and in some cases a dummy-variable, that is the equations for the import shares are given the following specifications

$$\text{eq. 5.6.} \quad cq_i^t = a_0+a_2*trend+a_3*Dummy$$

eq. 5.7. $ch_i^t = a_0+a_2*trend+a_3*Dummy$

eq. 5.8. $ci_i^t = a_0+a_2*trend+a_3*Dummy$

The estimation results for these equations are given in the tables 5.2-5.4 respectively.

Looking at the estimation results, although the specification is extremely simple and additional explaining variables such as a measure of the competitive power or the utilization rate might be included, the estimations show a significant trendwise increase in the import shares of the three industrial branches, that is a_1 is significant and negative. For the interpretations of the coefficients it should be mentioned that the trend is defined as (year/1975-1) that is normalized to zero in 1975. This implies that $(1-a_0)$ may be interpreted as a measure of the average import share.

Concluding on the import equations, although the analysis and specification of the import shares have been rather mechanic, the set-up makes it possible to perform fairly detailed analysis of the import, and for a next version of the model the determination of the import shares may be based on more profound analysis and given a more behavioural specification.

Table 5.2. Estimation results for the import share in deliveries to intermediary consumption: cq_i^t

Branch	a_0	a_1	Dummy	R^2	DW
A	0.891 (488.76)	3.564 (4.85)	–	0.61	2.59
E	0.473 (24.64)	-14.555 (-4.30)	D6680	0.61	1.37
Q	0.472 (81.51)	-15.376 (-7.64)	D7579	0.82	1.37
K	0.541 (170.74)	-7.813 (-6.12)	–	0.71	0.92
C	0.675 (205.46)	-1.286 (-0.97)	–	0.06	1.00
L	0.994 (3195.51)	-0.050 (-0.40)	–	0.01	0.88

Table 5.2. Estimation results for the import share in deliveries to private consumption: ch_i^t

Branch	a_0	a_1	Dummies	R^2	DW
A	0.565 (72.41)	0.916 (0.32)	D7579	0.61	1.86
E	0.664 (104.04)	-2.557 (-0.72)	D6772,D8283	0.87	2.13
Q	0.582 (133.48)	-18.069 (-15.15)	D7179,D8183	0.98	3.01
K	0.312 (61.36)	-12.819 (-7.92)	D7378,D8081	0.89	2.28
C	0.810 (635.73)	-9.856 (-19.18)	–	0.96	2.39

Table 5.4. Estimation results for the import share in deliveries to investments: ci_i^t

Branch	a_0	a_1	Dummies	R^2	DW
Q	0.669 (42.60)	-30.834 (-4.51)	D6672	0.91	1.91
K	0.404 (68.05)	9.205 (4.39)	D7376	0.74	2.21
C	0.770 (160.61)	-0.645 (-0.33)	-	0.01	0.75

6. THE INTERFUEL SUBSTITUTION MODEL

6.1. Introduction

In the late 1970's and early 1980's when the set-up of the HERMES-model was formulated a major economic problem was the energy crisis and the dependency of oil products. In this light one of the aims of the model was to analyse the interaction between the economic development and the energy consumption, and in relation to this the possibilities for substitution between different fuels, especially the possibilities for reducing the oil-dependency. At the aggregate level the energy-economy interactions are described by treating energy as a special factor of input and as specific categories of private consumption. In this section the research into formulating a model for the substitution between different fuels is presented. Compared to the complete model the interfuel substitution part is quite large containing 178 out of 1053 equations, however, when the subject of analysis is a pure economic matter where the interfuel substitution is without importance this part of the model may be left out. This reduces the national model to 875 equations which given the computational facilities may be a more manageable size. Especially when the different national models are linked together in order to perform a multinational simulation the computational gains of leaving out the interfuel substitution parts may be quite important.

6.2. A few concepts of production theory

Representing technology by a production function in components of capital (K), labour (L), and energy (E)

eq. 6.1. $Q = f(K,L,E)$

the assumption of weak separability implies that eq. 6.1. can be written as:

eq. 6.2. $Q = f(K(\underline{k}),\ L(\underline{l}),\ E(\underline{e}))$

where K, L and E now denote aggegator functions for components of capital ($\underline{k} = (k_1,\ k_2\ \ldots)$), labour ($\underline{l} = (l_1,\ l_2\ \ldots)$) and energy ($\underline{e} = (e_1,\ e_2\ \ldots)$) respectively.

Assuming cost minimizing behaviour the theory of duality between cost and production implies that the technology represented by eq. 6.2. equally may be represented by a cost function of the form

eq. 6.3. $c = g(p_K(\underline{p}_k,Q),\ p_L(\underline{p}_k,Q),\ p_E(\underline{p}_e,Q),Q)$

where c is the minimum cost of producing the output Q, and where p_K, p_L, p_E are cost functions aggregating component factor prices (p_k, p_l, p_e) into unit cost functions for aggregate capital, labour and energy.

Now assuming homotheticity in the component factors eq. 6.3 reduces to

eq. 6.4. $c = g(p_K(\underline{p}_k),\ p_L(\underline{p}_l),\ p_E(\underline{p}_e),\ Q)$

and the optimization is performed in two separate stages.

In one stage the mix of components is optimized with respect to the relative component factor prices, and in the other stage the optimal quantities of aggregate inputs K, L and E are determined.

The interfuel substitution is concerned with the optimal mix of fuels and is derived from the unit energy cost function

eq. 6.5. $c_E = p_E(p_{e1}, p_{e2}, \dots p_{en})$

where c_E is the minimum cost of consuming one unit of aggregate energy. If c_E satisfies the regularity conditions for duality, according to Shephard's Lemma (Diewert (1971)) a set of cost minimizing factor demand equations are obtained simply by differentiating the cost function w.r.t. the factor prices, that is

eq. 6.6. $E_i = \delta c_E / \delta p_{ei} \qquad i = 1, \dots n$

where E_i is the cost minimizing demand for fuel type i.

For empirical purposes the demand equations are often transformed into a set of cost share equations which are derived as

eq. 6.7. $v_i = (p_{ei}/c_E)E_i = (\delta c_E / \delta p_{ei})(p_{ei}/c_E)$

$$= \delta \log(c_E)/\delta \log(p_{ei})$$

Finally for a cost function to be well behaved the system of cost share equations has to satisfy the conditions of adding up and homogeneity of degree zero in the prices. Furthermore, the predicted cost shares have to be non-negative and the cost function has to satisfy the conditions of Slutsky symmetry and negative semi-definiteness of the Hessian matrix.

The conditions for adding up, homogenity and symmetry are normally imposed on the functional form to be estimated while the conditions for non-negativity of the cost shares and the negative semi-definiteness of the Hessian matrix have to be checked afterwards.

6.3. Specification of the cost function

For the empirical implementation two flexible cost functions, the Generalized Leontief cost function proposed by Diewert (1971) and the Translog cost function proposed by Christensen, Jorgensen and Lau (1973) have been tested. These functions provide local second-order approximations to an arbitrary cost function, have non-constant elasticities of substitution and place no a priori restrictions on the substitution elasticities.

The Generalized Leontief cost function is a square-root second-order approximation containing the quadratic terms only and may for n factors be written as

eq. 6.8. $$c = (h(E) \sum_i \sum_j (b_{ij} p_i^{1/2} p_j^{1/2}) \qquad i, j = 1 \dots n$$

where h(E) is an unspecified continuous, monotonically increasing function of aggregate energy, b_{ij} are parameters to be estimated and p_i and p_j are prices of the different fuels.

Applying Shephard's Lemma (eq. 6.6) the cost minimizing factor demand equations are obtained as eq. 6.9. $E_i = h(E) \sum_j (b_{ij} p_i^{-1/2} p_j^{1/2}) \qquad i, j = 1 \ldots n$

and the cost share equations are given by

eq. 6.10. $v_i = p_i E_i / \sum_k p_k E_k$

$$= (p_i^{1/2} \sum_j (b_{ij} p_j^{1/2})) / (\sum_k \sum_l (b_{kl} p_k^{1/2} p_l^{1/2}))$$

Looking at this equation the cost function is homothetic in aggregate energy as $h(E)$ vanishes from eq. 6.10. Further the system ensures adding-up in cost shares and homogeneity of degree zero in factor prices. Symmetry is imposed by the restrictions $b_{ij} = b_{ji}$.

The partial own and cross price elasticities are calculated by using

eq. 6.11. $\zeta_{ij} = \sigma_{ij} v_j = (c\, c_{ij})/(c_i c_j) v_j$

where σ_{ij} is the Allen partial elasticities of substitution and where $c_i = \delta c / \delta p_i$ and $c_{ij} = \delta^2 c / \delta p_i \delta p_j$.

Applying eq. 6.11 to the cost function eq. 6.8 the own and cross price elasticities are calculated as

eq. 6.12. $\zeta_{ij} = 0.5((b_{ij} p_j^{1/2}) / \sum_k b_{ik} p_k^{1/2}) - \delta_{ij})$

where $\delta_{ij} = 1$ for $i=j$ and else zero.

The Translog cost function is a logarithmic second-order approximation containing both linear and quadratic terms and may for n factors be written as eq. 6.13. $\log(c) = \alpha_0+\alpha_E\log(E)+\sum_i \alpha_i\log(p_i)+0.5\ \beta_{EE}(\log(E))^2$

$$+ 0.5 \sum_i \sum_j \beta_{ij}\log(p_i)\ \log(p_j)$$

$$+ \sum_i \beta_{Ei}\log(E)\ \log(p_i) \qquad i, j = 1 \ldots n$$

Applying Shephard's Lemma the derived cost share equations are

eq. 6.14. $v_i = \delta\log(c)/\delta\log(p_i) =$

$$\alpha_i+\sum_j(\beta_{ij}\log(p_j))+\beta_{Ei}\log(E)$$

For this system the assumption of homogeneity implies that $\beta_{Ei} = 0$ and eq. 6.14 reduces to

eq. 6.15. $v_i = \alpha_i+\sum_j(\beta_{ij}\log(p_j)) \qquad i, j = 1 \ldots n$

where α_i and β_{ij} are parameters to be estimated. The conditions of adding-up, homogeneity of degree zero in prices and symmetry imply the following parameter restrictions

eq. 6.16. $\sum_i \alpha_i = 1$

$$\sum_i \beta_{ij} = \sum_j \beta_{ij} = 0 \text{ and}$$

$$\beta_{ij} = \beta_{ji} \qquad i, j = 1 \ldots n$$

Applying eq. 6.11 to the Translog cost function gives the partial own and cross price elasticities

eq. 6.17. $\zeta_{ij} = (\beta_{ij}+v_i v_j)/v_i$ for $i \neq j$

and $\zeta_{ii} = (\beta_{ii}+v_i^2-v_i)/v_i$

The cost share models presented so far are based on a static cost minimizing model assuming the production technique to be fully optimized w.r.t. prevailing factor prices. Estimation of these models requires data representing long run equilibrium situation. Using annual data this requirement is hardly fulfilled. Therefore in the estimation the equations are given a dynamic specification allowing the short run and the equilibrium adjustments to differ.

Assuming that the cost share equations derived from the static model represent the long run equilibrium or desired cost shares, the adjustment towards the targets can be described in a variety of ways. The most simple and widely used adjustment model is the partial adjustment model assuming a geometric adjustment process. Denoting the actual cost shares by v_{it} and the equilibrium shares by v_{it}^* this model has the form

eq. 6.18. $v_{it}-v_{it-1} = k(v_{it}^*-v_{it-1})$ $i = 1 \ldots n$

where k is the adjustment parameter which as a consequence of adding-up in both actual and desired shares has to be identical for each of the shares.

When used for budget shares the partial adjustment mechanism is not quite satisfactory as the first year adjustment and the lagged adjustments in budget shares are of quite different nature. Looking at a once and for all shift in the price of one of the fuels the first year effect on the budget share for this fuel is a combination of the price change and, in the normal case an off-setting change in the volume of the fuel used. After the first year changes in the budget share represent pure volume adjustments. To overcome this problem the more flexible Error Correction Mechanism has been chosen. Following this model the adjustment is described as a proportion of the change in the optimal share plus a proportion of the one year lagged difference between the optimal and actual shares, that is the first year change and the lagged changes are treated separately.

Parallel to eq. 6.18 the Error Correction Mechanism can be written as

eq. 6.19. $v_{it}-v_{it-1} = k_1(v^*_{it}-v^*_{it-1})+k_2(v^*_{it-1}-v_{it-1})$

where k_1 and k_2 are adjustment parameters which due to the adding-up have to be identical for each of the shares. For the adjustment process to converge it is required that $0<k_2<2$. The characteristics of the volume adjustment depending on the share elasticity and the adjustment parameters are given in table 6.1. The share elasticity SE* is positive when the equilibrium budget share increases with an increase in the fuel price and negative when the equilibrium budget share decreases with an increase in the fuel price.

From table 6.1 it is noticed that a smooth quantity adjustment is obtained when the share elasticity is positive and $1<k_1<2$, $0<k_2<1$ and when the share elasticity is negative and $0<k_1,k_2<1$.

Table 6.1. Characteristics of the adjustment process for the Error Correction Mechanism

	SE* > 0	SE* < 0
$0<k_1<1$ $0<k_2<1$	first year overreaction, thereafter smooth	smooth
$0<k_1<1$ $1<k_2<2$	first year overreaction, thereafter alternating	alternating
$1<k_1<2$ $0<k_2<1$	smooth	first year overreaction, thereafter smooth
$1<k_1<2$ $1<k_2<2$	alternating	first year overreaction, thereafter alternating

6.4. Estimation results for the interfuel substitution model

For each of the branches of the model the interfuel substitution model divides the total energy consumption between the fuels

C: Solid fuels
O: Fluid fuels, and
E: Electricity.

For the two service branches "Other market services" and "Non-market services" where no solid fuels are used and where district heating, contrary to the other branches, has a major share of the energy budget, district heating is separated from the fluid fuels. The data for the estimation are aggregates of the 1966 to 1980 energy balances published yearly by the Danish Statistical Office.

From preliminar estimations of the static Generalized Leontief and Translog cost function, that is the equations 6.10 and 6.15, it was concluded that the two models perform almost identically w.r.t. goodness of fit and the size of the elasticities. Therefore, as the Generalized Leontief model is highly non-linear in the parameters and therefore difficult to estimate while the Translog model is linear in the parameter and relatively easy to estimate, for the dynamic version only the Translog model has been tested. The set of dynamic equations estimated simultaneously are derived from eq. 6.19 replacing v^*_{it} and v^*_{it-1} by the Translog equations 6.15 imposing the restrictions 6.16 on the parameters and restricting the adjustment parameters k_1 and k_2 respectively to be identical in each of the share equations. The results of the estimations are shown in table 6.2 and the implied short and long-term partial own and cross price elasticies are shown in table 6.3.

Concluding on the estimations in general the results are acceptable and especially for the industrial branches Q, K and C the results are quite interpretable. For these branches the own price elasticities lie between 0 and -1, k_1 is about 1.5 and k_2 about 0.2 which implies a smooth quantity adjustment with a first year adaption of about half the equilibrium adjustment and a relatively slow long-term adaption.

Table 6.2. Estimation results for error-correction translog model

	$\alpha 1$	$\alpha 2$	$\beta 12$	$\beta 13$	$\beta 23$	k_1	k_2	LF	R_1^2	R_2^2	R_3^2
A	0.722		-0.143			1.135	1.113	48.26	0.98	0.98	
	(5.87)		(-6.60)			(7.30)	(3.29)				
E	0.086	0.904	0.072	-0.005	-0.007	0.865	0.684	107.46	0.61	0.61	0.90
	(4.90)	(47.62)	(2.24)	(-0.92)	(-1.38)	(3.94)	(4.66)				
Q	0.151	0.513	-0.016	-0.035	-0.084	1.437	0.177	86.03	0.59	0.80	0.91
	(5.06)	(3.25)	(-0.59)	(-1.22)	(-1.21)	(1.41)	(0.56)				
K	0.035	0.455	-0.031	0.006	-0.107	1.455	0.355	88.25	0.82	0.97	0.95
	(3.37)	(29.20)	(-0.30)	(0.38)	(-5.58)	(4.78)	(2.58)				
C	0.048	0.512	0.004	-0.011	-0.091	1.735	0.198	105.94	0.91	0.84	0.94
	(5.86)	(13.16)	(1.28)	(-2.45)	(-2.71)	(2.48)	(1.35)				
B	1.577		-0.420			0.371	0.186	25.27	0.82	0.82	
	(0.87)		(-0.80)			(1.27)	(0.60)				
Z	1.072		-0.027			0.995	0.823	48.40	0.49	0.49	
	(1.34)		(-1.29)			(2.36)	(0.96)				
L	0.393	0.161	-0.014	-0.052	-0.012	3.236	0.230	70.30	0.48	0.54	0.72
	(6.15)	(8.51)	(-0.47)	(-0.53)	(-0.63)	(0.63)	(1.77)				
N	0.480	0.160	-0.007	0.032	-0.036	1.379	1.123	60.75	0.01	0.43	0.00
	(23.37)	(30.44)	(-0.07)	(0.36)	(-0.69)	(0.75)	(4.40)				

Table 6.3. Own- and cross-price elasticities for the inter-fuel sub-model

		Own-price elasticities			Cross-price elasticities		
		s	f	e	s - f	s - e	f - e
A	LR		-0.12	-0.24			0.35
	SR		-0.09	-0.18			0.26
E	LR	-1.58	-0.19	-0.12	1.82	-2.37	0.47
	SR	-1.49	-0.18	-0.24	1.71	-1.93	0.53
Q	LR	-0.50	-0.26	-0.30	0.80	0.18	0.49
	SR	-0.35	-0.18	-0.13	0.72	-0.18	0.28
K	LR	-0.40	-0.25	-0.29	-0.58	1.26	0.53
	SR	-0.15	-0.10	-0.20	-1.30	1.37	0.31
C	LR	-0.79	-0.31	-0.33	1.19	0.37	0.60
	SR	-0.66	-0.19	-0.16	1.32	-0.09	0.31
B	LR		0.31	0.95			-1.26
	SR		-0.04	-0.12			0.16
Z	LR		-0.03	-0.50			0.53
	SR		-0.03	-0.50			0.53
L*	LR	-0.68	-0.39	-0.46	0.82	0.80	0.70
	SR	-0.32	-0.08	-0.07	0.40	0.36	-0.03
N*		-0.57	-0.57	-0.63	0.91	0.37	1.19
		-0.47	-0.59	-0.63	0.88	0.14	1.26

s : solid f: fluid e: electricity

LR: long-term elasticity SR: short-term elasticity

* for these branches s is district heating

For the non-industrial branches B and Z the estimation violates the assumption of non-negativity of budget shares and for branch B the positive own price elasticities violate the assumption of concavity of the cost function. Therefore, for these branches the equations included in the model are fixed average budget shares.

Concluding on substitutability and complementarity between the fuels in general the fuels are substitutes, however, for the energy branch E complementarity exists between solid fuels and elasticity and for branch K solid and fluid fuels are complementary.

Finally, concerning the energy consumption by private households the consumption of solid fuels is determined by a negative trend, the consumption of fluid fuels is determined by the consumption categories "fuels for domestic use" and "fuels for personal transportation" and the consumption of electricity is determined by the consumption categories "fuels for domestic use" and "power for domestic use".

7. A SIMULATION OVER THE PAST AND MULTIPLICATOR ANALYSES

7.1. A simulation over the past

In order to evaluate the working of the model and see whether the model is able to trace the past development a dynamic simulation over the period 1975 to 1986 is performed and the results are compared to the actual development.

For a few of the central aggregated national account variables the simulated and the actual development is shown in Fig. 7.1, and for these and additional national account variables the mean absolute percent error (MAPE) between the simulated and actual values are shown in Table 7.1. At a more disaggregated level the MAPE's for the output by branch and the household consumption by category of consumer goods are shown in Table 7.2.

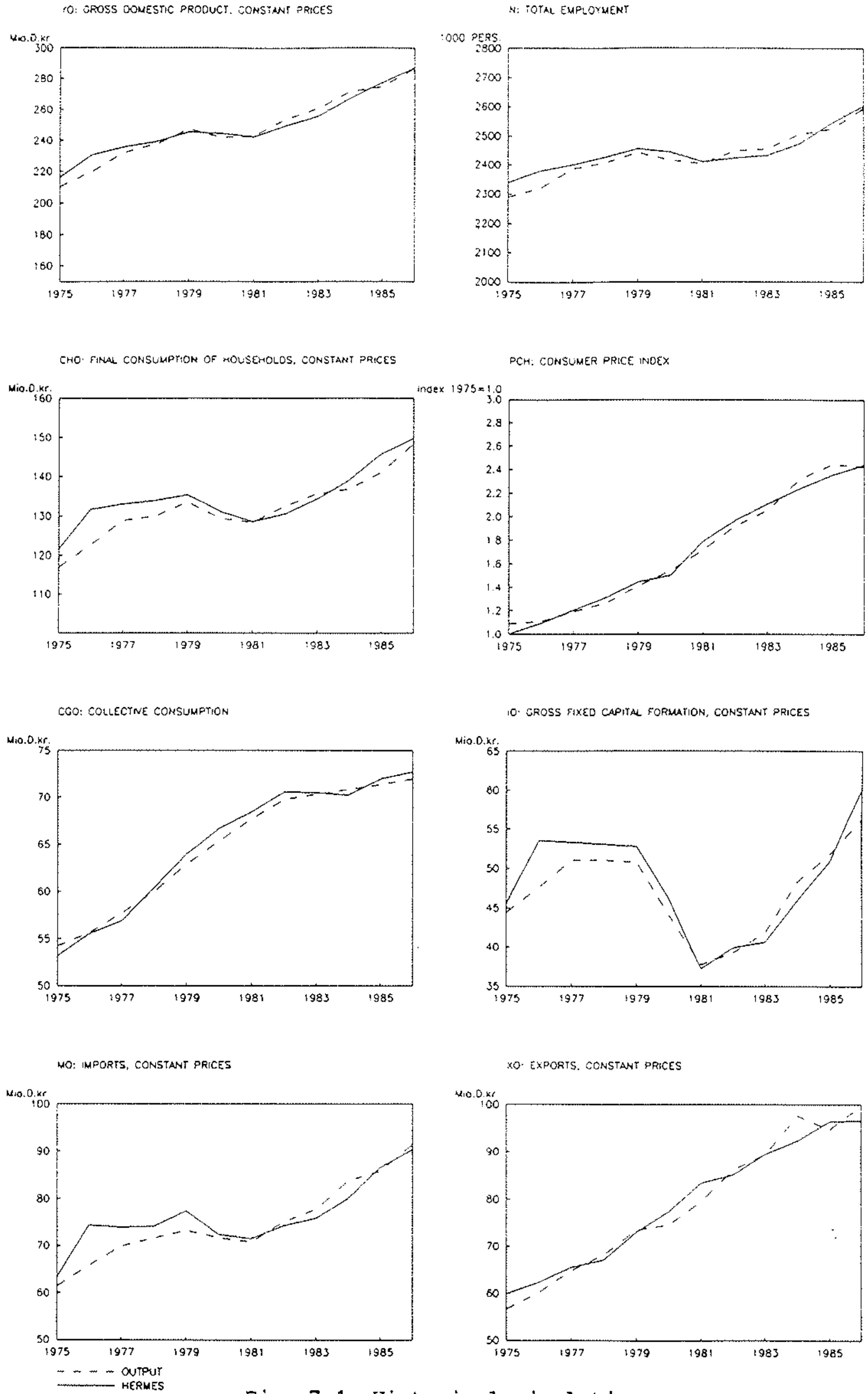

Fig. 7.1. Historical simulation

Looking at Fig. 7.1 at the aggregate level the model appears to trace the past development fairly acceptable. Looking at the gross domestic product at constant prices YO and the total employment N the model starts by underestimating the values in 1975-76 with about 2-4%. From 1977 to 1984 the model captures the development fairly close but in 1985 the model has problems with capturing the increase, especially the employment increase is only partly captured. Looking at the total employment although the MAPE is only about 1% the average absolute error is about 25000 persons, which is a fairly large error compared to the total number of unemployed. Looking at the final consumption of households CHO again the model starts by underestimating the values but from 1978 to 1986 the model captures the development fairly closely. Concerning the consumer price index PCH and the collective consumption CGO the model traces the development closely but comming to the gross fixed capital formation IO the percent errors are fairly high for some of the years. Especially the model has problems in capturing the drastic increase in 1976, the following decrease in 1977 and the increase in 1986. Concerning the 1976-77 development a major part of the errors are ascribed to the households investments in dwellings IRO, while the 1986 error is ascribed to a drastic increase in the gross fixed capital formation by branches, which the model is unable to explain. Finally looking at the import MO and export XO the development is captured reasonably, however concerning the import the model is unable to explain the drastic increase in 1976 and concerning the export the model overestimates the figure for 1984. Looking at the import and export at current prices and calculating the trade balance some of the errors net out but the percent errors increase drasticly. The average absolute error for the trade balance is about 5.5 mia.Dkr. which is a fairly large figure relative to the trade balance, however seen in relation to the total import and export the figure is not frightning.

Table 7.1. Simulation errors for the period 1975-86. National account variables

Variable	MAPE	Variable	MAPE
YU	3.5	YO	1.5
VU	3.6	VO	1.8
CHU	3.1	CHO	2.3
XU	2.9	XO	2.7
MU	4.2	MO	3.4
PCH	2.6	IO	4.0
YDH	2.9	IRO	7.4
WBU	3.6	CGO	1.1
GOSH	2.4	N	1.0
DTH	3.0	VQHR	1.1
WRT	3.4	WPCR	2.3

YU, YO	Gross domestic product at market prices, current and constant prices respectively.
VU, VO	Gross domestic product at factor prices, current and constant prices respectively.
CHU, CHO	Final consumption of household, current and constant prices respectively.
XU, XO	Exports of goods and services, current and constant prices respectively.
MU, MO	Imports of goods and services, current and constant prices respectively.
PCH	Comsumer price index: 1975 = 1.0.
YDH	Gross disposable income.
WBU	Compensation of emplyees.
GOSH	Gross operating surplus.

DTH	Direct taxes of households.
WRT	Average wage rate.
IO	Gross fixed capital formation, constant prices.
IRO	Gross fixed capital formation in construction of dwellings, constant prices.
CGO	Collective consumption, constant prices.
N	Total employment.
VQHR	Average productivety per man-hour, constant prices.
WPCR	Real average wage rate.

Looking at the MAPE values given in Table 7.1 in general the errors are acceptable and at the aggregate level the model describes the past development reasonably. The largest MAPE value is observed for the gross fixed capital formation in the construction of dwellings IRO, which is a variable characterized by relatively large annual changes, and to a certain extend under policy control. Looking at the average wage rate WRT the model contains a Phillip's curve representation of the wage formation and this equation describes the past development reasonably, however as the average wage rate is a main object of the income policy and wage-rates are negotiated for two-year periods, the wage rate may be exogenous at least within the negotiation period. Finally comparing the variables in current and constant prices, the constant price variables are observed to perform slightly better than the current price variables, that is errors in the price-variables add to the errors in the description of the real economy.

Table 7.2. Simulation errors for the period 1975-86. Disaggregated level

Variable	MAPE	Variable	MAPE
QFOA	6.4	COC 1	1.7
QFOE	11.2	COC 2	9.0
QFOQ	3.4	COC 3	2.3
QFOK	3.9	COC 4	11.0
QFOC	3.8	COC 5	5.9
QFOB	3.1	COC 6	6.9
QFOZ	3.1	COC 7	7.7
QFOL	0.9	COC 8	26.5
QFON	2.1	COC 9	13.6
		COC10	8.2
		COC11	9.3
		COC12	4.8
		COC13	3.5
		COC14	3.2
		COC15	9.3

QFO_i Gross output by branch, constant prices

CO_c Final consumption of household by consumption category, constant prices.

Looking at the gross output by branch QFO_i the MAPE-values given in Table 7.2 are in general quite acceptable and for most of the branches of the same magnitude as the MAPE-values for the aggregate national account variables given in Table 7.1. The exceptions are the branches A: Agriculture and E: Fuel and power products. Concerning branch A the model overestimates the output increases in the period 1978 to 1984 and concerning branch E the output is in general overestimated except for the years 1979 and 1980.

For branch A the problem is caused by too simple a description of the deliveries to variation of stocks and for the energy branch E the errors are equally devided between the deliveries to intermediary consumption and final consumption of households.

Looking at the MAPE-values for the categories of household consumption the percent errors are inversely proportional to the share of the consumer budget. For the major categories of consumer goods C1: Food, drink and tobacco, C3: Rents and C14: Hotels, restaurants and other services the MAPE-values are within 2-4% which is quite acceptable. For the relatively small categories of consumer goods with budget shares about 2-3%, although the MAPE-values are somewhat higher the absolute errors are within an acceptable size. Looking at categories with relatively high MAPE-values and a considerable share of the consumer budget the categories C2, C4, C8, and C9 are chosen. Concerning C2: Clothing and footwear the model is unable to explain a 16% increase in 1976, but besides 1976 the yearly changes are traced reasonably. Concerning C4: Fuels and power for heating the model overestimates the effects of the drastic fuelprice changes in 1979 and 1986. Concerning C8: Personal transport equipment the model is unable to capture the drastic yearly changes but gives a more smooth description of the development. Finally concerning C9: Fuels for personal transportation the model calculates an increasing consumption after 1982 while the actual consumption has been almost constant. This points to a behavioral change in the fuel consumption for personal transportation after the second fuel price increase which the model is unable to capture.

Finally looking very superior at the simulation results for other disaggregated parts of the model the external trade - and the price and wage parts of the model perform reasonable, however concerning the interfuel substitution part the percent errors are quite large and a more conscientions calibration of some of the equations are needed before reliable simulation results may be obtained.

7.2. Multiplicator analyses

In order to examine the overall characteristics of the model and see how changes in different exogenous variables affect the endogenous variables a number of multiplicator analyses are performed. Technically a multiplicator experiment compares two simulations; a base-simulation and an alternative simulation where one or more of the exogenous variables are changed. For the experiments presented in this section the base-simulation is the same and only one of the exogenous variables is changed at the time. Possible effects between the exogenous variables are not considered and the average wage rate WRT is assumed exogenous in all the experiments. For the central variables of the model the results of the experiments are summarized in Table 7.3.

In the first experiment the consumption of the general government in constant 1975-prices is assumed exogenous and increased by 1 mia.Dkr. or about 1.3%. This affects the real economy by increasing the deliveries to the public consumption and thereby the production, employment and investments by the branches. The increased production and employment increases the real disposable income and thereby the private household consumption. Finally the increased production, investments and private consumption increases the import and thereby deteriorates the trade-balance. In total the gross domestic product is increased with about 1.4 mia.D.kr., the employment is increased with about 4.000 persons, the private consumption and the investments are each increased with about 0.2 mia.D.kr. and the trade-balance is deteriorated with about 0.3 mia.D.kr.

In the second experiment the public employment is increased by 12000 persons which equals an increase in the consumption of the general government in constant prices of 1 mia.D.kr. This change operates much through the same channels as the first experiment, however as the direct employment effect and thereby the effect on the real disposable income is much larger the total effects are much larger, especially when looking at the first year effects. After the first few years the derived effects are reduced quite substantially. The gross domestic product in constant prices is increased by 2.4 mia.D.kr. the first year which after 5 years are reduced to an increase of 1.7 mia.D.kr. The immediate increase in the total employment is 20800 persons and after 5 years the increase is reduced to 16900 persons, that is besides the 12000 public employed the employment is increased by 8800 the first year which after 5 years is reduced to an increase of 4900 persons. Looking at the private consumption the immediate increase is about 0.9 mia.D. kr. which after 5 years are reduced to an increase of 0.2 mia.D.kr. and for the investments the first year increase is about 0.8 mia. D.kr. which after 5 years is reduced to an increase of 0.5 mia.D.kr. Finally looking at the trade-balance the immediate effect is a deterioration of 0.7 mia.D.kr. which after 5 years is reduced to 0.2 mia.D.kr. Comparing the first two experiments the immediate indirect effects of experiment two (the increase of the public employment) are much larger than in the first experiment, however after 5 years the derived indirect effects are much the same in the two experiments.

In the third experiment the rate of social transfers is increased by 1% which is equal to an increase in the social benefit receipts of households in current prices of about 900 mill.D.kr. This affects the real economy by increasing the real disposable income and thereby the private household consumption, which again increase the production, employment and investments of branches and deteriorates the trade-balance by increasing the imports. The immediate increase in the private consumption in constant prices is 156 mill.D.kr. which after 5 years grows to an increase of 210 mill.D.kr. The gross domestic product at constant prices grows from an immediate increase of 211 mill.D.kr. to an increase after 5 years of 337 mill.D.kr. and the immediate increase in the employment of 1000 persons grows to an increase of 1500 persons. The trade-balance is deteriorated with 72 mill.D.kr. which after 5 years is reduced to a deterioration of 41 mill.D.kr.

The fourth experiment comprices an increase of the direct tax-rate of 0.5% or equally an increase of the direct taxes with about 1.1 mia.D.kr. This experiment operates much like the third experiment just with the opposite sign, that is the primary effect goes through a reduction of the real disposable income of households. The private consumption of households in constant prices is reduced by 0.2 mia.D.kr. increasing to a reduction of about 0.3 mia.D.kr. after 5 years. The gross domestic product is reduced by 0.3 mia. D.kr. increasing to a reduction of 0.5 mia.D.kr. after 5 years, and the employment is reduced with 1500 persons increasing to 2300 persons after 5 years. Finally the trade-balance is improved with 0.1 mia.D.kr., however after 5 years the improvement is only 0.07 mia.D.kr.

In the fifth experiment all the indirect tax-rates per consumer category ITR_c are increased by 5%, which equals an increase of the indirect taxes of about 5 mia.D.kr. or an increase of the average indirect tax-rate of 0.7% points. The effects of this change operates mainly through an immediate increase in the consumer price index of 0.6% and a decrease of the real disposable income. The private consumption in constant prices is reduced by 0.7 mia.D.kr. the first year and after 5 years the consumption is reduced by 1 mia.D.kr. The gross domestic product is reduced by 0.9 mia.D.kr. which after 5 years has increased to a reduction of 1.5 mia.D.kr. and the employment is immediatly reduced by 3400 persons which after 5 years has grown to a reduction of 5900 persons. The trade-balance is slightly improved with about 0.3 mia.D.kr. each year.

In the sixth experiment the average wage rate is increased by 1% holding the social transfer rate exogenous and constant. The effects of wage changes operate mainly through changes in the disposable income, the costs of production and the derived changes in the consumer price index. The experiment shows that a 1% increase in the wage rate increases the disposable income by 0.7% and the consumer prices by 0.36%, that is the real disposable income is increased by 0.34%. In equilibrium this increases the private household consumption in constant prices with 0.28% or about 0.4 mia. D.kr. The gross domestic product in constant prices is increased with about 0.4 mia.D.kr. and in equilibrium the total employment is increased by 2700 persons and the investments are increased with about 0.2 mia.D.kr. Finally the trade-balance is deteriorated with about 0.6 mia.D.kr. per year.

The final analysis experiment no. 7 comprices a 10% devaluation of the Danish crown, that is the variable EEXR, the number of foreign currencies paid per Danish crown is reduced by 10% and the exchange rate EX expressing the number of Danish crowns per $ is increased by 10%. The main effects of this change operates through an increase in the competitiveness of Danish products and through a reduction of the real disposable income.

Looking at the exports and imports in constant prices the export is increased with about 1.3% the first year increasing to about 2% after 5 years while the imports are reduced by less than 0.5%. In current Danish crowns the trade-balance is improved by about 9 mia.D.kr. the first year and after 5 years by about 16 mia.D.kr. The import price increase transforms through the output prices to an increase in the consumer price index of 2.2%, which implies a decrease in the real disposable income of about 1.3%. The private consumption of households is decreased by 0.4 mia.D.kr. the first year, however the second and following years the decrease is about 1.2 mia.D.kr. Now looking at the gross domestic product in constant prices the changes are mainly ascribed to the increasing exports and the decreasing private consumption, that is the first year changes is an increase of about 1.7 mia.D.kr., the second year where most of the decrease in the private consumption is realized the increase in the gross domestic product is reduced to about 1 mia.D.kr. After the second year the increasing export strikes through implying a gradually increase in the gross domestic product which after 5 years has increased by 1.7 mia.D.kr. The employment changes mirror the changes in the gross domestic product, the first year the employment increases about 8400 persons, the second year the increase is reduced to 4600 persons and after 5 years the employment has increased with about 7700 persons.

Table 7.3. Multiplicator analyses

Experiment no. 1		Change in the consumption of the general government CGO: Simulated	Difference	%	Experiment no. 2		Change in the public employment NG increase by 12000 persons: Simulated	Difference	%
CGO	1	74320	1000	1.35	CGO	1	74320	1000	1.35
	2	74904	1000	1.34		2	74904	1000	1.34
	3	75487	1000	1.33		3	75487	1000	1.33
	4	75738	1000	1.32		4	75738	1000	1.32
	5	75988	1000	1.32		5	75988	1000	1.32
YO	1	311338	1389	0.45	YO	1	311338	2433	0.78
	2	319338	1382	0.43		2	319338	1957	0.61
	3	327549	1383	0.42		3	327549	1787	0.55
	4	334228	1388	0.42		4	334228	1736	0.52
	5	341357	1390	0.41		5	341357	1743	0.51
N	1	2661.5	4.0	0.15	N	1	2661.5	20.8	0.78
	2	2677.6	3.8	0.14		2	2677.6	18.5	0.69
	3	2694.4	3.7	0.14		3	2694.4	17.4	0.65
	4	2696.9	3.6	0.13		4	2696.9	17.0	0.63
	5	2706.2	3.5	0.13		5	2706.2	16.9	0.62
PCH	1	2.85	0.00	0.005	PCH	1	2.85	0.00	0.015
	2	2.93	0.00	0.003		2	2.93	0.00	0.007
	3	3.02	0.00	0.002		3	3.02	0.00	0.004
	4	3.11	0.00	0.004		4	3.11	0.00	0.003
	5	3.20	0.00	0.002		5	3.20	0.00	0.003
SXM	1	36539	-339	-0.93	SXM	1	36539	-698	-1.91
	2	45419	-271	-0.60	SXM	2	45419	-376	-0.83
	3	55462	-228	-0.41		3	55462	-258	-0.47
	4	66836	-198	-0.30		4	66836	-213	-0.32
	5	79483	-174	-0.22		5	79483	-196	-0.25
CHO	1	150088	231	0.15	CHO	1	150088	853	0.57
	2	151748	190	0.13		2	151748	408	0.27
	3	153189	172	0.11		3	153189	260	0.17
	4	153358	165	0.11		4	153358	219	0.14
	5	153379	158	0.10		5	153379	213	0.14
IO	1	63273	248	0.39	IO	1	63273	756	1.19
	2	64486	243	0.38		2	64486	610	0.95
	3	65738	236	0.36		3	65738	545	0.83
	4	66491	229	0.34		4	66491	512	0.77
	5	67389	221	0.33		5	67389	511	0.76
YDH	1	547771	741	0.14	YDH	1	547771	1294	0.24
	2	569977	752	0.13		2	569977	1099	0.19
	3	591355	765	0.13		3	591355	1029	0.17
	4	606332	780	0.13		4	606332	1021	0.17
	5	621445	783	0.13		5	621445	1045	0.17

Table 7.3. (continued)

Experiment no. 3		Change in social benefit rate WBGR + 1%			Experiment no. 4		Change in direct tax rate DTHR, DTHR + 0.5%		
		Simulated	Difference	%			Simulated	Difference	%
SBH	1	112989	921	0.82	DTH	1	236997	1116	0.47
	2	114566	856	0.75		2	240795	1114	0.46
	3	116017	865	0.75		3	243887	1114	0.46
	4	118555	882	0.74		4	250065	1139	0.46
	5	119771	890	0.74		5	256299	1165	0.45
YO	1	311338	211	0.07	YO	1	311338	-322	-0.10
	2	319338	295	0.09		2	319338	-431	-0.13
	3	327549	314	0.10		3	327549	-483	-0.15
	4	334228	329	0.10		4	334228	-503	-0.15
	5	341357	337	0.10		5	341357	-520	-0.15
N	1	2661.5	1.0	0.04	N	1	2661.5	-1.5	-0.06
	2	2677.6	1.4	0.05		2	2677.6	-2.0	-0.07
	3	2694.4	1.4	0.05		3	2694.4	-2.2	-0.08
	4	2696.9	1.5	0.05		4	2696.9	-2.2	-0.08
	5	2706.2	1.5	0.05		5	2706.2	-2.3	-0.08
PCH	1	2.85	0.00	0.002	PCH	1	2.85	-0.00	-0.003
	2	2.93	0.00	0.005		2	2.93	-0.00	-0.003
	3	3.02	0.00	0.003		3	3.02	-0.00	-0.004
	4	3.11	0.00	0.003		4	3.11	-0.00	-0.004
	5	3.20	0.00	0.003		5	3.20	-0.00	-0.004
SXM	1	36539	-72	-0.20	SXM	1	36539	111	0.30
	2	45419	-81	-0.18		2	45419	118	0.26
	3	55462	-66	-0.12		3	55462	106	0.19
	4	66836	-53	-0.08		4	66836	84	0.13
	5	79483	-41	-0.05		5	79483	67	0.08
CHD	1	150088	156	0.10	CHO	1	150088	-238	-0.16
	2	151748	203	0.13		2	151748	-303	-0.20
	3	153189	208	0.14		3	153189	-323	-0.21
	4	153358	211	0.14		4	153358	-325	-0.21
	5	153379	210	0.14		5	153379	-326	-0.21
IO	1	63273	69	0.11	IO	1	63273	-105	-0.17
	2	64486	100	0.15		2	64486	-138	-0.21
	3	65738	104	0.16		3	65738	-157	-0.24
	4	66491	106	0.16		4	66491	-161	-0.24
	5	67389	107	0.16		5	67389	-165	-0.24
YDH	1	547771	870	0.16	YDH	1	547771	-1344	-0.25
	2	569977	940	0.16		2	569977	-1417	-0.25
	3	591355	963	0.16		3	591355	-1472	-0.25
	4	606332	990	0.16		4	606332	-1518	-0.25
	5	621445	1006	0.16		5	621445	-1562	-0.25

Table 7.3. (continued)

Experiment no.		Change in the indirect tax rate ITCR		
		$ITCR_i$ + 5% ≈ ITCR + 0.7% point		
5		Simulated	Difference	%
IT	1	162408	5123	3.15
	2	169616	4984	2.94
	3	176757	5064	2.86
	4	182370	5178	2.84
	5	188025	5305	2.82
YO	1	311338	− 881	-0.28
	2	319338	-1245	-0.39
	3	327549	-1404	-0.43
	4	334228	-1474	-0.44
	5	341357	-1523	-0.45
N	1	2661.5	-3.4	-0.13
	2	2677.6	-5.0	-0.19
	3	2694.4	-5.6	-0.21
	4	2696.9	-5.8	-0.21
	5	2706.2	-5.9	-0.22
PCH	1	2.85	0.02	0.62
	2	2.93	0.02	0.62
	3	3.02	0.02	0.62
	4	3.11	0.02	0.62
	5	3.20	0.02	0.62
SXM	1	36539	290	0.79
	2	45419	347	0.76
	3	55462	323	0.58
	4	66836	275	0.41
	5	79483	232	0.29
CHO	1	150088	− 698	-0.47
	2	151748	− 926	-0.61
	3	153189	-1000	-0.65
	4	153358	-1016	-0.66
	5	153379	-1021	-0.66
IO	1	63273	-240	-0.38
	2	64486	-358	-0.56
	3	65738	-408	-0.62
	4	66491	-424	-0.64
	5	67389	-435	-0.65
YDH	1	547771	-358	-0.07
	2	569977	-549	-0.10
	3	591355	-646	-0.11
	4	606332	-692	-0.11
	5	621445	-729	-0.12

Table 7.3. (continued)

Experiment no. 6		Change in the average wage rate WRT + 1% Simulated	Difference	%
WRT	1	01972	0002	1.01
	2	02002	0002	1.00
	3	02032	0002	0.98
	4	02063	0002	1.02
	5	02093	0002	1.00
YO	1	311338	269	0.09
	2	319338	392	0.12
	3	327549	443	0.14
	4	334228	466	0.14
	5	341357	472	0.14
N	1	2661.5	1.9	0.07
	2	2677.6	2.5	0.09
	3	2694.4	2.6	0.10
	4	2696.9	2.7	0.10
	5	2706.2	2.7	0.10
PCH	1	2.85	0.010	0.36
	2	2.93	0.010	0.36
	3	3.02	0.011	0.35
	4	3.11	0.011	0.36
	5	3.20	0.011	0.36
SXM	1	36539	-488	-1.33
	2	45419	-619	-1.36
	3	55462	-589	-1.06
	4	66836	-594	-0.89
	5	79483	-592	-0.74
CHO	1	150088	305	0.20
	2	151748	396	0.26
	3	153189	413	0.27
	4	153358	423	0.28
	5	153379	419	0.28
IO	1	63273	155	0.25
	2	64486	231	0.36
	3	65738	236	0.36
	4	66491	238	0.36
	5	67389	237	0.35
YDH	1	547771	3833	0.70
	2	569977	3983	0.70
	3	591355	4070	0.69
	4	606332	4296	0.71
	5	621445	4332	0.70

Experiment no. 7		Devaluation 10% EEXR - 10% EX + 10% Simulated	Difference	%
EEXR	1	086	-0086	-10.00
	2	086	-0086	-10.00
	3	086	-0086	-10.00
	4	086	-0086	-10.00
	5	086	-0086	-10.00
YO	1	311338	1698	0.55
	2	319338	989	0.31
	3	327549	1030	0.31
	4	334228	1313	0.39
	5	341357	1718	0.50
N	1	2661.5	8.4	0.31
	2	2677.6	4.6	0.17
	3	2694.4	4.7	0.17
	4	2696.9	5.9	0.22
	5	2706.2	7.7	0.29
PCH	1	2.85	0.064	2.24
	2	2.93	0.066	2.26
	3	3.02	0.068	2.25
	4	3.11	0.070	2.25
	5	3.20	0.072	2.24
SXM	1	36539	9051	24.77
	2	45419	11121	24.49
	3	55462	12865	23.20
	4	66836	14669	21.95
	5	79483	16616	20.91
CHO	1	150088	- 367	-0.24
	2	151748	-1128	-0.74
	3	153189	-1290	-0.84
	4	153358	-1280	-0.83
	5	153379	-1214	-0.79
IO	1	63273	155	0.25
	2	64486	-212	-0.33
	3	65738	-295	-0.45
	4	66491	-280	-0.42
	5	67389	-210	-0.31
YDH	1	547771	5155	0.94
	2	569977	5034	0.88
	3	591355	5287	0.89
	4	606332	5630	0.93
	5	621445	6063	0.98

APPENDIX A

Listing of the model

MODEL: HERMES1

SYMBOL DECLARATIONS

ENDOGENOUS:

CCHO1 CCHU1 CGO CGU CHA CHC CHE CHK CHO CHO1 CHQ CHU CHU1 CIC CIK CIQ CM CNO CNU COC1 COC10 COC11 COC12
COC13 COC14 COC15 COC2 COC3 COC4 COC5 COC6 COC7 COC8 COC9 COST_EC COST_EK COST_EQ COST_KC COST_KK COST_KQ CQA
CQC CQE CQK CQL CQQ CUC1 CUC10 CUC11 CUC12 CUC13 CUC14 CUC15 CUC2 CUC3 CUC4 CUC5 CUC6 CUC7 CUC8 CUC9 DITK DM
DPU DPUF DPUG DPUH DTF DTH EEC EEK EEQ EFOA1 EFOA2 EFOA3 EFOT EFPT EFUA1 EFUA2 EFUA3 EFUT EGOA2 EGOA3 EGOT
EGUA2 EGUA3 EGUT EHOA1 EHOA2 EHOA3 EHOT EHUA1 EHUA2 EHUA3 EHUT EICA1 EICA2 EICA3 EICRT EICT EIMA1 EIMA2 EIMA3
EIMRT EIMT EMOA1 EMOA2 EMOA3 EMOT EMUA1 EMUA2 EMUA3 EMUT EOAA2 EOAA3 EOAET EOBA2 EOBA3 EOBET EOCA1 EOCA2 EOCA3
EOCET EOEA1 EOEA2 EOEA3 EOEET EOKA1 EOKA2 EOKA3 EOKET EOLA1 EOLA2 EOLA3 EOLET EONA1 EONA2 EONA3 EONET EOQA1
EOQA2 EOQA3 EOQET EOZA2 EOZA3 EOZET EQOA1 EQOA2 EQOA3 EQOT EQUA1 EQUA2 EQUA3 EQUT ESOA1 ESOA2 ESOT ESUA1 ESUA2
ESUT EUAA2 EUAA3 EUAET EUBA2 EUBA3 EUBET EUCA1 EUCA2 EUCA3 EUCET EUEA1 EUEA2 EUEA3 EUEET EUKA1 EUKA2 EUKA3
EUKET EULA1 EULA2 EULA3 EULET EUNA1 EUNA2 EUNA3 EUNET EUQA1 EUQA2 EUQA3 EUQET EUZA2 EUZA3 EUZET EXOA1 EXOA2
EXOA3 EXOT EXUA1 EXUA2 EXUA3 EXUT GM GOSA GOSB GOSC GOSE GOSF GOSG GOSH GOSK GOSL GOSN GOSQ GOST GOSZ H HA
HB HC HE HK HL HN HPT HQ HT HZ IDF IDG IDH IDH1 IDH2 IFU IHU IO IOA IOB IOC IOE IOK IOL ION IOQ IOT
IOZ IQO IQU IRO IRU IT ITA ITB ITC ITCR ITC1 ITC10 ITC11 ITC12 ITC13 ITC14 ITC15 ITC2 ITC3 ITC4 ITC5 ITC6
ITC7 ITC8 ITC9 ITE ITF ITFA ITFB ITFC ITFE ITFK ITFL ITFN ITFQ ITFRA ITFRB ITFRC ITFRE ITFRK ITFRL ITFRN
ITFRQ ITFRT ITFRZ ITFT ITFZ ITG ITGR ITIG ITIQ ITIR ITK ITL ITM ITMA ITMC ITME ITMK ITML ITMQ ITMRT ITMT ITN
ITQ ITQA ITQB ITQC ITQE ITQK ITQL ITQN ITQQ ITQT ITQTOT ITQZ ITR ITS ITT ITZ IU IUA IUB IUC IUE IUG IUK
IUL IUN IUQ IUT IUZ MCO MCU MGO MGOS MGU MGUS MO MOA MOC MOE MOK MOL MOQ MSO MSU MU MUA MUC MUE MUK MUL
MUQ N NAA NAT NB NC ND NEE NF NFA NFB NFC NFE NFFC NFFK NFFQ NFK NFL NFN NFQ NFT NFZ NHEC NHEK NHEQ NI
NIA NIB NIC NIK NIL NIQ NIT NIZ NK NL NN NQ NT NZ OCUG PAA PAA1 PAA2 PAA3 PAB PAC PAE PAET PAK PAL PAN
PAQ PAT PAZ PBA PBB PBC PBE PBK PBL PBN PBQ PBZ PCG PCH PCHELP PCHH PCM PCN PCW PC1 PC1H PC10 PC10H PC11
PC11H PC12 PC12H PC13 PC13H PC14 PC14H PC15 PC2 PC2H PC3 PC3H PC4 PC4H PC5 PC5H PC6 PC6H PC7 PC7H PC8 PC8H
PC9 PC9H PEAET PEBET PECET PEEET PEFT PEGT PEHT PEKET PELET PEMT PENET PEQET PEQT PESA1 PESA2 PEST PEXT PEZET
PGM PHA PHB PHC PHE PHK PHL PHN PHQ PHT PHZ PI PIA PIB PIC PIE PIG PIK PIL PIN PIQ PIR PIT PIZ PM PMGS
PMS PQA PQB PQC PQE PQEA PQEA1 PQEA2 PQEA3 PQEB PQEC PQEE PQEK PQEL PQEN PQEQ PQET PQEZ PQFA PQFB PQFC PQFE
PQFK PQFL PQFN PQFQ PQFT PQFZ PQGA PQGB PQGC PQGE PQGK PQGL PQGN PQGQ PQGT PQGZ PQHA PQHB PQHC PQHE PQHK
PQHL PQHN PQHQ PQHT PQHZ PQI PQIA PQIB PQIC PQIE PQIK PQIL PQIN PQIQ PQIT PQIZ PQK PQL PQMA PQMC PQME PQMK
PQML PQMQ PQMT PQN PQOA PQOB PQOC PQOE PQOK PQOL PQON PQOQ PQOT PQOZ PQQ PQQA PQQB PQQC PQQE PQQK PQQL PQQN
PQQQ PQQT PQQZ PQSA PQSC PQSE PQSK PQSL PQSQ PQST PQT PQVA PQVB PQVC PQVE PQVK PQVL PQVN PQVQ PQVT PQVZ PQXA
PQXC PQXE PQXK PQXL PQXN PQXQ PQXT PQXZ PQYA PQYB PQYC PQYE PQYK PQYL PQYN PQYQ PQYT PQYZ PQZ PV PWT PX PXG
PXGS PXM PXMRA PXMRC PXMRE PXMRK PXMRL PXMRN PXMRQ PXMRT PXMRZ PXR PXS PY QCUF QCUH QEOA QEOB QEOC QEOE QEOK
QEOL QEON QEOQ QEOT QEOZ QEUA QEUB QEUC QEUE QEUK QEUL QEUN QEUQ QEUT QEUZ QFOA QFOB QFOC QFOE QFOK QFOL
QFON QFOQ QFOT QFOZ QFUA QFUB QFUC QFUE QFUK QFUL QFUN QFUQ QFUT QFUZ QGOA QGOB QGOC QGOE QGOK QGOL QGON
QGOQ QGOT QGOZ QGUA QGUB QGUC QGUE QGUK QGUL QGUN QGUQ QGUT QGUZ QHOA QHOB QHOC QHOE QHOK QHOL QHON QHOQ
QHOT QHOZ QHUA QHUB QHUC QHUE QHUK QHUL QHUN QHUQ QHUT QHUZ QIOA QIOB QIOC QIOE QIOK QIOL QION QIOQ QIOT
QIOZ QIUA QIUB QIUC QIUE QIUK QIUL QIUN QIUQ QIUT QIUZ QLOA QLOB QLOE QLOL QLON QLOZ QMOA QMOC QMOE QMOK
QMOL QMOQ QMOT QMUA QMUC QMUE QMUK QMUL QMUQ QMUT QOA QOB QOC QOE QOK QOL QON QOOA QOOB QOOC QOOE QOOK QOOL
QOON QOOQ QOOT QOOZ QOQ QOT QOUA QOUB QOUC QOUE QOUK QOUL QOUN QOUQ QOUT QOUZ QOZ QPC QPK QPQ QQOA QQOB
QQOC QQOE QQOK QQOL QQON QQOQ QQOT QQOZ QQRC QQRK QQRQ QQUA QQUB QQUC QQUE QQUK QQUL QQUN QQUQ QQUT QQUZ QRA
QRC QRE QRK QRQ QSOA QSOC QSOE QSOK QSOL QSOQ QSOT QSUA QSUC QSUE QSUK QSUL QSUQ QSUT QUA QUB QUC QUE QUK
QUL QUN QUQ QUT QUZ QVOA QVOB QVOC QVOE QVOK QVOL QVON QVOQ QVOT QVOZ QVUA QVUB QVUC QVUE QVUK QVUL QVUN
QVUQ QVUT QVUZ QXOA QXOC QXOE QXOK QXOL QXON QXOQ QXOT QXOZ QXUA QXUC QXUE QXUK QXUL QXUN QXUQ QXUT QXUZ
QYOA QYOB QYOC QYOE QYOI QYOK QYOL QYON QYOQ QYOT QYOZ QYUA QYUB QYUC QYUE QYUI QYUK QYUL QYUN QYUQ QYUT
QYUZ SAE2 SAE3 SBE2 SBE3 SBF SBG SBH SCE1 SCE2 SCE3 SEE1 SEE2 SEE3 SF SFR SH SHR SKE1 SKE2 SKE3 SLE1 SLE2
SLE3 SNE1 SNE2 SNE3 SO SQE1 SQE2 SQE3 SSF SSFA SSFB SSFC SSFE SSFK SSFL SSFN SSFQ SSFRT SSFT SSFZ SSH SU
SUB SW SWA SWC SWE SWK SWL SWN SWQ SWRA SWRC SWRE SWRK SWRL SWRN SWRQ SWRT SWRZ SWS SWT SWZ SXM SXMR SZE2
SZE3 TC_EC TC_EK TC_EQ TC_KC TC_KK TC_KQ U UR VO VOHR VONR VU WBA WBB WBC WBE WBF WBFR WBG WBGR WBK WBL
WBN WBQ WBT WBU WBZ WPCR WRA WRB WRC WRE WRK WRL WRN WRQ WRT WRZ XGO XGOS XGU XGUS XO XOA XOC XOE XOK
XOL XON XOQ XOZ XRU XSO XSU XU XUA XUC XUE XUK XUL XUN XUQ XUZ YDH YDTG YNN YO YSSF YSSG YU

EXOGENOUS:

CGOCORR CILEVB DTFR DTHR D6672 D6676 D6678 D6680 D6772 D69 D70 D7077 D71 D7174D77 D7179 D72 D7272 D7276 D73
D7373 D7374 D7376 D7378 D7380 D74 D74D76 D74D77 D75 D7575 D7576 D7578 D7579 D7585 D7678 D7679 D77 D7777 D7778
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D8592 D8692 D8792 D8800 EFPA1 EFPA2 EFPA3 EICRA1 EICRA2 EICRA3 EIMRA1 EIMRA2 EIMRA3 EX HAFT HDAG HPA HPB HPC
HPE HPK HPL HPQ HPZ IGU IMEXUA IMEXUC IMEXUE IMEXUK IMEXUL IMEXUQ IOG IRGCORR ITCR1 ITCR10 ITCR11 ITCR12 ITCR13
ITCR14 ITCR15 ITCR2 ITCR3 ITCR4 ITCR5 ITCR6 ITCR7 ITCR8 ITCR9 ITGOSG ITGOSH ITIGR ITIQR ITIRR ITMR ITMRA ITMRB
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COEFFICIENT:

AA AA1 AB AB1 AC AC1 AE AE1 AK AK1 AL AL1 AN AN1 AQ AQ1 AZ AZ1 B010050 B010051 B010110 B010111 B010220
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EC1 EC12 EC13 EC2 EC23 EEKA1 EEQA1 EE1 EE12 EE13 EE2 EE23 EK1 EK12 EK13 EK2 EK23 EL1 EL12 EL13 EL2 EL23 EN1
EN12 EN13 EN2 EN23 EQ1 EQ12 EQ13 EQ2 EQ23 EZ2 EZ23 FIA FIB FIC FIE FIK FIL FIN FIQ FIZ GA1 GB1 GC1 GE1
GK1 GL1 GN1 GQ1 GZ1 IOCA1 IOCA2 IOCA3 IOCA4 IOCA5 IOC71 IOC72 IOC74 IOC79 IOKA1 IOKA2 IOKA3 IOKA4 IOKA5 IOK71
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PARAMETER:

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WRQ75 WRT75 WRZ75

MODEL: HERMES1

```
 1:    CHU == PCH*CHO
 2:    CHO = CCHO1-MCO+XRO
 3:    PCHH = QHUA/QHUT*PQFA+QHUE/QHUT*PQFE+QHUQ/QHUT*PQFQ+QHUK/QHUT*PQFK+QHUC/QHUT*PQFC+QHUB/QHUT*PQFB+QHUZ/QHUT*PQFZ+QHUL/
       QHUT*PQFL+QHUN/QHUT*PQFN
 4:    ITCR = (ITC1+ITC2+ITC3+ITC4+ITC5+ITC6+ITC7+ITC8+ITC9+ITC10+ITC11+ITC12+ITC13+ITC14+ITC15)/CHU
 5:    DEL(1 : LOG(PCH)) = C000+C001*DEL(1 : LOG(PCHH))+DEL(1 : (1+ITCR)/(1+0.16274))
 6:    CGU = CGO*PCG
 7:    CGO = B010050+B010051*NG+CGOCORR
 8:    PCG = PQFN
 9:    IU = IO*PI
10:    IO = IRO+IOG+IQO
11:    PI = (IRO*PIR+IOG*PIG+IQO*PQI)/IO
12:    SU = SO*PS
13:    SO = B010110+B010111*(QSOA+QSOE+QSOQ+QSOK+QSOC+QSOL)
14:    XU == QXUA+QXUE+QXUQ+QXUK+QXUC+QXUZ+QXUL+QXUN+IMEXUA+IMEXUE+IMEXUQ+IMEXUK+IMEXUC+IMEXUL+SDXU
15:    XO == QXOA+QXOE+QXOQ+QXOK+QXOC+QXOZ+QXOL+QXON+IMEXUA/PQMA+IMEXUE/PQME+IMEXUQ/PQMQ+IMEXUK/PQMK+IMEXUC/PQMC+IMEXUL/PQML+
       SDXO
16:    PX == XU/XO
17:    MU == QMUA+QMUE+QMUQ+QMUK+QMUC+QMUL+QMUR+SDMU
18:    MO == QMOA+QMOE+QMOQ+QMOK+QMOC+QMOL+QMOR+SDMO
19:    PM == MU/MO
20:    YU == CHU+CGU+IU+SU+XU-MU
21:    YO == CHO+CGO+IO+SO+XO-MO
22:    PY == YU/YO
23:    IT == ITF+ITM
24:    ITF = B010220+B010221*ITFT
25:    ITM == ITMR*MU
26:    ITQTOT == ITQR*VU
27:    ITR == IT/(YU-IT)
28:    SUB == SUBR*VU/(1+SUBR)
29:    VU == QVUA+QVUE+QVUQ+QVUK+QVUC+QVUB+QVUZ+QVUL+QVUN-QYUI-ITGOSH-ITGOSG
30:    VO == QVOA+QVOE+QVOQ+QVOK+QVOC+QVOB+QVOZ+QVOL+QVON-QYOI-ITGOS75*VO
31:    PV = VU/VO
32:    YNN = YU-DPU+YN+YK+TXM
33:    WBU == WBF+WBG
34:    WBF == WBA+WBE+WBQ+WBK+WBC+WBB+WBZ+WBL
35:    WBG == WBN
36:    WBFR == WBF*1000/NF
37:    WBGR = B010400+B010401*WBFR
38:    DPU == DPUF+DPUG+DPUH
39:    DPUF = DPU-DPUG-DPUH
40:    DPUH = 0
41:    LOG(DPUG) = B010430+B010431*LOG(DPUG(-1))+(1-B010431)*LOG(IGU)+B010432*DEL(1 : LOG(PIG))
42:    SSF = SSFR*WBF/(1+SSFR)
43:    SSH = SSHR*(WBU+GOSH-SSH-SSF)
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44:   YSSG = SSF+SSH
45:   YSSF = 0
46:   SBH = B010510+B010511*(WBGR*U)+B010512*WBGR*(NPQ-NPA)+B010513*D6678
47:   SBG = SBH
48:   SBF = 0
49:   LOG(GOSH) = B010470+B010471*LOG(QFUA+QFUE+QFUQ+QFUK+QFUC+QFUB+QFUZ+QFUL+QFUN)+B010472*D8081+B010473*D8392
50:   GOSG = GOSN-ITGOSG
51:   GOSF = 0
52:   IDH = IDH1+IDH2
53:   IDH1 = B010570+B010571*VU+B010572*SI+B010573*D74D77
54:   IDH2 = B010580+B010581*VU+B010582*SI
55:   IDG = B010590+B010591*(0.8*SLG(-1)*SI+0.2*SLG(-2)*SI)+B010592*SI(-1)
56:   IDF = 0
57:   DTH = DTHR*(YDH+DTH)
58:   DTF = DTFR*(GOSF-IDF)
59:   YDTG = DTH+DTF
60:   QCUH = 0
61:   QCUG = B010660+B010661*(YDTG+YSSG+IT+GOSG)
62:   QCUF = 0
63:   SH = YDH-CHU+XRU-MCU
64:   SF = 0
65:   SHR = SH/YDH
66:   SFR = 0
67:   YDH = WBU+GOSH+QCUH-SSH-SSF+SBH+IDH-DTH-YDHCOR
68:   IHU = IRU
69:   IFU = IRU+IUG+IQU-IHU-IGU+SU
70:   SXM == XU-MU+XRU-MCU
71:   SXMR == SXM/(XU+XRU)
72:   SW = SXM+YN+YK+TXM
73:   SWS == SW/EX
74:   PXM = PX/PM
75:   IRU == PIR*IRO
76:   LOG(IRO) = (1-LIRO)*B010930+(1-LIRO)*B010931*LOG(YDH/PCH)+B010932*(LOG(UR)-LIRO*LOG(UR(-1)))+B010933*D8082+LIRO*LOG(
      IRO(-1))+IROCORR
77:   PIR = CIRB*PAB+CIRL*PAL
78:   IUS == PIG*IDG
79:   PIG = CIGQ*PAQ+CIGK*PAK+CIGC*PAC+CIGB*PAB+CIGL*PAL
80:   IQU = IUA+IUE+IUQ+IUK+IUC+IUB+IUZ+IUL
81:   IQO = IOA+IOE+IOQ+IOK+IOC+IOB+IOZ+IOL
82:   PQI == IQU/IQO
83:   NAT == NAR*NPA
84:   N == NI+NF+NG
85:   NI == (NIA+NIQ+NIK+NIC+NIB+NIZ+NIL)/1000
86:   NF == (NFA+NFE+NFQ+NFK+NFC+NFB+NFZ+NFL)/1000
87:   ND == NF+NG
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88:   U = NAT-N
89:   UR == U/NAT
90:   H == (HA*NFA+HE*NFE+HQ*NFQ+HK*NFK+HC*NFC+HB*NFB+HZ*NFZ+HL*NFL+HN*NFN)/(NFA+NFE+NFQ+NFK+NFC+NFB+NFZ+NFL+NFN)
91:   VQNR == VQ/N*1000
92:   VQHR == VQNR/H
93:   WPCR == WBU/(N*PCH)
94:   LOG(QYUI) = B020200+B020201*LOG(QVUL)-0.2*D8283
95:   LOG(QYDI) = B020210+B020211*LOG(QVQL)-0.2*D8283
96:   DITK = 0
97:   ITG = ITGR*(CGU+CNU)/(1+ITGR)
98:   ITGR = 0
99:   ITIR = ITIRR*IRU/(1+ITIRR)
100:  ITIG = ITIGR*IUG/(1+ITIGR)
101:  ITIQ = ITIQR*IQU/(1+ITIQR)
102:  ITS == ITSR*SU/(1+ITSR)
103:  DEL(1 : LOG(PCW)) = CW0+CW1*DEL(1 : LOG(PCH))
104:  CHD1 = CCHD1/NPQ
105:  LOG(CCHD1) = (1-L)*B030010+(1-L)*B030011*LOG(YDH/PCH)+B030012*(UR-UR(-1)-L*(UR(-1)-UR(-1)))+L*LOG(CCHD1(-1))+B030013*
      D8587
106:  CCHU1 = CCHD1*PCW
107:  CHU1 = CCHU1/NPQ
108:  CM == (CCHU1+XRU-CNU)/(NPQ/1000)
109:  DM == DEL(1 : CM)
110:  GM == (CM+CM(-1))/2
111:  PCHELP = L1*(DEL(1 : PC1)/GM)+L2*(DEL(1 : PC2)/GM)+L3*(DEL(1 : PC3)/GM)+L4*(DEL(1 : PC4)/GM)+L5*(DEL(1 : PC5)/GM)+L6*(
      DEL(1 : PC6)/GM)+L7*(DEL(1 : PC7)/GM)+L8*(DEL(1 : PC8)/GM)+L9*(DEL(1 : PC9)/GM)+L10*(DEL(1 : PC10)/GM)+L11*(DEL(1 :
      PC11)/GM)+L12*(DEL(1 : PC12)/GM)+L13*(DEL(1 : PC13)/GM)+L14*(DEL(1 : PC14)/GM)+L15*(DEL(1 : PC15)/GM)
112:  DEL(1 : CUC1/(NPQ/1000))/GM = M1*DM/GM+L1*(DEL(1 : PC1)/GM)-M1*PCHELP
113:  DEL(1 : CUC2/(NPQ/1000))/GM = M2*DM/GM+L2*(DEL(1 : PC2)/GM)-M2*PCHELP
114:  DEL(1 : CUC3/(NPQ/1000))/GM = M3*DM/GM+L3*(DEL(1 : PC3)/GM)-M3*PCHELP
115:  DEL(1 : CUC4/(NPQ/1000))/GM = M4*DM/GM+L4*(DEL(1 : PC4)/GM)-M4*PCHELP
116:  DEL(1 : CUC5/(NPQ/1000))/GM = M5*DM/GM+L5*(DEL(1 : PC5)/GM)-M5*PCHELP
117:  DEL(1 : CUC6/(NPQ/1000))/GM = M6*DM/GM+L6*(DEL(1 : PC6)/GM)-M6*PCHELP
118:  DEL(1 : CUC7/(NPQ/1000))/GM = M7*DM/GM+L7*(DEL(1 : PC7)/GM)-M7*PCHELP
119:  DEL(1 : CUC8/(NPQ/1000))/GM = M8*DM/GM+L8*(DEL(1 : PC8)/GM)-M8*PCHELP
120:  DEL(1 : CUC9/(NPQ/1000))/GM = M9*DM/GM+L9*(DEL(1 : PC9)/GM)-M9*PCHELP
121:  DEL(1 : CUC10/(NPQ/1000))/GM = M10*DM/GM+L10*(DEL(1 : PC10)/GM)-M10*PCHELP
122:  DEL(1 : CUC11/(NPQ/1000))/GM = M11*DM/GM+L11*(DEL(1 : PC11)/GM)-M11*PCHELP
123:  DEL(1 : CUC12/(NPQ/1000))/GM = M12*DM/GM+L12*(DEL(1 : PC12)/GM)-M12*PCHELP
124:  DEL(1 : CUC13/(NPQ/1000))/GM = M13*DM/GM+L13*(DEL(1 : PC13)/GM)-M13*PCHELP
125:  DEL(1 : CUC14/(NPQ/1000))/GM = M14*DM/GM+L14*(DEL(1 : PC14)/GM)-M14*PCHELP
126:  DEL(1 : CUC15/(NPQ/1000))/GM = (1-M1-M2-M3-M4-M5-M6-M7-M8-M9-M10-M11-M12-M13-M14)*DM/GM+L15*(DEL(1 : PC15)/GM)-(1-M1-
      M2-M3-M4-M5-M6-M7-M8-M9-M10-M11-M12-M13-M14)*PCHELP
127:  CDC1 = CUC1/PC1
128:  CDC2 = CUC2/PC2
129:  CDC3 = CUC3/PC3
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130:    COC4 = CUC4/PC4
131:    COC5 = CUC5/PC5
132:    COC6 = CUC6/PC6
133:    COC7 = CUC7/PC7
134:    COC8 = CUC8/PC8
135:    COC9 = CUC9/PC9
136:    COC10 = CUC10/PC10
137:    COC11 = CUC11/PC11
138:    COC12 = CUC12/PC12
139:    COC13 = CUC13/PC13
140:    COC14 = CUC14/PC14
141:    COC15 = CUC15/PC15
142:    PC1H = 0.0742*PQFA+0.0012*PQFQ+0.5938*PQFC+0.3307*PQFL
143:    PC2H = 0.0012*PQFA+0.0002*PQFQ+0.0009*PQFK+0.603*PQFC+0.3947*PQFL
144:    PC3H = 0.9857*PQFL+0.0143*PQFN
145:    PC4H = 0.0004*PQFA+0.813*PQFE+0.0094*PQFD+0.0021*PQFC+0.1749*PQFL
146:    PC5H = PQFE
147:    PC6H = 0.048*PQFL+0.952*PQFN
148:    PC7H = 0.0036*PQFA+0.0003*PQFE+0.1113*PQFQ+0.1443*PQFK+0.3014*PQFC+0.4377*PQFL+0.0013*PQFN
149:    PC8H = 0.0002*PQFQ+0.5864*PQFK+0.4134*PQFL
150:    PC9H = 0.5922*PQFE+0.0072*PQFQ+0.0029*PQFC+0.3978*PQFL
151:    PC10H = 0.9959*PQFZ+0.0041*PQFL
152:    PC11H = PQFZ
153:    PC12H = 0.1139*PQFQ+0.0359*PQFK+0.0239*PQFC+0.7524*PQFL+0.074*PQFN
154:    PC13H = 0.0464*PQFA+0.0044*PQFQ+0.1646*PQFK+0.2412*PQFC+0.0047*PQFZ+0.4785*PQFL+0.0602*PQFN
155:    PC14H = 0.0162*PQFE+0.0219*PQFQ+0.0139*PQFK+0.0517*PQFC+0.0175*PQFZ+0.8074*PQFL+0.0713*PQFN
156:    DEL(1 : LOG(PC1)) = CC010+CC011*DEL(1 : LOG(PC1H))+CC012*DEL(1 : (1+ITCR1)/(1+0.380089))
157:    DEL(1 : PC2) = CC020+CC021*DEL(1 : PC2H)+CC022*DEL(1 : (1+ITCR2)/(1+0.12528))
158:    DEL(1 : PC3) = CC030+CC031*DEL(1 : PC3H)+CC032*D7575
159:    DEL(1 : LOG(PC4)) = CC040+CC041*DEL(1 : LOG(PC4H))+CC042*D7777+CC043*D7979+CC044*DEL(1 : (1+ITCR4)/(1+0.12283))
160:    DEL(1 : LOG(PC5)) = CC050+CC051*DEL(1 : LOG(PC5H))+CC052*D7575+CC053*D7878+CC054*DEL(1 : (1+ITCR5)/(1+0.147413))
161:    DEL(1 : LOG(PC6)) = CC060+CC061*DEL(1 : LOG(PC6H))+CC062*D7575
162:    DEL(1 : LOG(PC7)) = CC070+CC071*DEL(1 : LOG(PC7H))+CC072*D7575+CC073*DEL(1 : (1+ITCR7)/(1+0.1396))
163:    DEL(1 : PC8) = CC080+CC081*DEL(1 : PC8H)+CC082*D7272+CC083*DEL(1 : (1+ITCR8)/(1+1.02498))
164:    DEL(1 : PC9) = CC090+CC091*DEL(1 : PC9H)+CC092*D7272+CC093*D7777+CC094*D7979+CC095*DEL(1 : (1+ITCR9)/(1+1.04294))
165:    DEL(1 : LOG(PC10)) = CC100+CC101*DEL(1 : LOG(PC10H))+0.*DEL(1 : (1+ITCR10)/(1+0.0119))
166:    DEL(1 : LOG(PC11)) = CC110+CC111*DEL(1 : LOG(PC11H))+CC112*D7373+CC113*D7878+CC114*DEL(1 : (1+ITCR11)/(1+0.122724))
167:    DEL(1 : LOG(PC12)) = CC121*DEL(1 : LOG(PC12H))+0.*DEL(1 : (1+ITCR12)/(1+0.052353))
168:    DEL(1 : LOG(PC13)) = CC130+CC131*DEL(1 : LOG(PC13H))+CC132*DEL(1 : (1+ITCR13)/(1+0.117569))
169:    PC15 = PCM
170:    ITC1 == ITCR1*CUC1/(1+ITCR1)
171:    DEL(1 : LOG(PC14)) = CC140+CC141*DEL(1 : LOG(PC14H))+CC142*DEL(1 : (1+ITCR14)/(1+0.124463))
172:    ITC2 == ITCR2*CUC2/(1+ITCR2)
173:    ITC3 == ITCR3*CUC3/(1+ITCR3)
174:    ITC4 == ITCR4*CUC4/(1+ITCR4)
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175:  ITC5 == ITCR5*CUC5/(1+ITCR5)
176:  ITC6 == ITCR6*CUC6/(1+ITCR6)
177:  ITC7 == ITCR7*CUC7/(1+ITCR7)
178:  ITC8 == ITCR8*CUC8/(1+ITCR8)
179:  ITC9 == ITCR9*CUC9/(1+ITCR9)
180:  ITC10 == ITCR10*CUC10/(1+ITCR10)
181:  ITC11 == ITCR11*CUC11/(1+ITCR11)
182:  ITC12 == ITCR12*CUC12/(1+ITCR12)
183:  ITC13 == ITCR13*CUC13/(1+ITCR13)
184:  ITC14 == ITCR14*CUC14/(1+ITCR14)
185:  ITC15 == ITCR15*CUC15/(1+ITCR15)
186:  CNU == PCN*CNO
187:  LOG(CNO) = B030760+B030761*LOG(CHO)+B030762*(TREND-1900)
188:  PCN = PAN
189:  QUA == QFUA+ITFA
190:  QOA == QFOA+ITFRA75*QFOA
191:  PQA == QUA/QOA
192:  QFUA == QFOA*PQFA
193:  QFOA = QQOA+QHOA+QSOA+QIOA+QSOA+QXOA
194:  LOG(PQFA) = B040060+B040061*LOG(PBA)+B040062*LOG(PQXA)
195:  QVUA == QFUA-QEUA-QOUA-ITQA
196:  QVOA == QFOA-QEOA-QOOA-ITQRA75*QFOA
197:  PQVA == QVUA/QVOA
198:  QEUA == QEOA*PQEA
199:  LOG(QEOA) = B040110+B040111*LOG(QFOA)+B040112*TREND
200:  LOG(PQEA) = B040120+B040121*LOG(PEAA2)+B040122*LOG(PEAA3)
201:  QOUA == QOOA*PQOA
202:  LOG(QOOA) = B040140+B040141*LOG(QFOA)
203:  PQOA = B040150+B040151*(CQAA*PQQA+CQAE*PQQE+CQAQ*PQQQ+CQAK*PQQK+CQAC*PQQC+CQAB*PQQB+CQAZ*PQQZ+CQAL*PQQL+CQAN*PQQN)/(
      CQAA+CQAE+CQAQ+CQAK+CQAC+CQAB+CQAZ+CQAL+CQAN)
204:  LOG(QLOA) = B040160+B040161*LOG(QFOA)+B040162*TREND+B040163*D8383
205:  ITA == ITFA+ITMA+ITQA
206:  ITFA+1000 = CCAC1*ITC1+CCAC2*ITC2+CCAC3*ITC3+CCAC4*ITC4+CCAC5*ITC5+CCAC6*ITC6+CCAC7*ITC7+CCAC8*ITC8+CCAC9*ITC9+CCAC10*
      ITC10+CCAC11*ITC11+CCAC12*ITC12+CCAC13*ITC13+CCAC14*ITC14+CCAC15*ITC15+CGA*ITG+CIRA*ITIR+CIGA*ITIG+CIGA*ITIQ+QSOA/QSOT
      *ITS+QXOA/QVOT*ITX
207:  ITFRA = ITFA/(QYUA-ITFA)
208:  ITQA = B040190+B040191*QFUA+B040192*D74D76
209:  ITMA == ITMRA*QMUA/(1+ITMRA)
210:  QYUA == QVUA+ITA
211:  QYOA = QVOA+ITRA75*QFOA
212:  PQYA == QYUA/QYOA
213:  WBA == WRA*NFA
214:  LOG(WRA) = WA0+WA1*LOG(WRT)+WA2*(TREND-1900)
215:  SSFA == SSFRA*WBA/(1+SSFRA)
216:  GOSA == QVUA-WBA
217:  IUA == IOA*PIA
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218:  LOG(IOA) = B040340+B040344*D7380+B040345*D7779+0.3*D8586
219:  DEL(1 :.LOG(PIA)) = B040350+DEL(1 : LOG(CIQA*PAQ+CIKA*PAK+CICA*PAC+CIBA*PAB+CILA*PAL))+DEL(1 : ITIQR)
220:  NAA = NFA+NIA
221:  LOG(NFA) = NA0+NA1*LOG(QFDA)+NA2*(TREND-1900)+NA3*D7982
222:  LOG(NIA) = NA4+NA5*(TREND-1900)
223:  HA = B040410+B040411*HT
224:  PHA = WRA/HA/(WRA75/HA75)
225:  QRA = QRGA
226:  CHA = B040630+B040631*(TREND/1975-1)+B040632*D7679
227:  QHUA = (CHAC1*CUC1+CHAC2*CUC2+CHAC3*CUC3+CHAC4*CUC4+CHAC5*CUC5+CHAC6*CUC6+CHAC7*CUC7+CHAC8*CUC8+CHAC9*CUC9+CHAC10*
      CUC10+CHAC11*CUC11+CHAC12*CUC12+CHAC13*CUC13+CHAC14*CUC14+CHAC15*CUC15)*(CHA/0.5842)
228:  QHDA = (CHAC1*COC1+CHAC2*COC2+CHAC3*COC3+CHAC4*COC4+CHAC5*COC5+CHAC6*COC6+CHAC7*COC7+CHAC8*COC8+CHAC9*COC9+CHAC10*
      COC10+CHAC11*COC11+CHAC12*COC12+CHAC13*COC13+CHAC14*COC14+CHAC15*COC15)*(CHA/0.5842)
229:  PQHA == QHUA/QHDA
230:  QGUA == QGDA*PQGA
231:  QGDA = CGA*(CGO+CNU)
232:  PQGA = PQA
233:  QIUA = (CIAA*IUA+CIAE*IUE+CIAQ*IUQ+CIAK*IUK+CIAC*IUC+CIAB*IUB+CIAZ*IUZ+CIAL*IUL+CIAN*IUN+CIRA*IRU)*1.
234:  QIDA = (CIAA*IDA+CIAE*IDE+CIAQ*IDQ+CIAK*IDK+CIAC*IDC+CIAB*IDB+CIAZ*IDZ+CIAL*IDL+CIAN*IDN+CIRA*IRD)*1.+1.000000E-06
235:  PQIA == QIUA/QIDA
236:  QSUA = QSDA*PQA
237:  QSDA = B040540+B040541*QFDA+B040542*D7578-1400.
238:  PQSA == PQA
239:  QXUA == QXDA*PQXA
240:  LOG(QXDA) = B040570+B040571*LOG(QFDA)+B040572*LOG(PQFA*KRKURS)+B040573*(TREND-1900)+B040574*D7174D77
241:  PQXA = PXA*EX/EXO
242:  CQA = B040620+B040621*(TREND/1975-1)-0.005*D8484-0.02*D8585-0.05*D8692
243:  QQUA == QQDA*PQQA
244:  QQDA = (CQAA*QQDA+CQEA*QDDE+CQQA*QDDQ+CQKA*QDDK+CQCA*QDDC+CQBA*QDDB+CQZA*QDDZ+CQLA*QDDL+CQNA*QDDN)*(CQA/0.9044)
245:  PQQA = PAA
246:  QMUA == QMDA*PQMA
247:  QMDA = QQDA/CQA-QQDA+QHDA/CHA-QHDA+IMEXUA/PQMA
248:  PQMA = PMA*EX/EXO
249:  LOG(PBA) = B040750+B040751*LOG(PQEA)+B040752*LOG(PQDA)+B040753*LOG(WRA/0.03796)+B040754*D8283
250:  PAA = PQFA
251:  SWA == QXUA-QMUA
252:  SWRA == SWA/QXUA
253:  PXMRA == PQXA/PQMA
254:  QUE == QFUE+ITFE
255:  QDE == QFDE+ITFRE75*QFDE
256:  PQE == QUE/QDE
257:  QFUE = QFDE*PQFE
258:  QFDE = QDDE+QHDE+QGDE+QIDE+QSDE+QXDE
259:  LOG(PQFE) = B050060+B050061*LOG(PBE)+B050062*LOG(PQME)+B050063*D8188-0.302*D8692
260:  QVUE == QFUE-QEUE-QOUE-ITQE
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261:  QVDE == QFDE-QEDE-QODE-ITQRE75*QFDE
262:  PQVE == QVUE/QVDE
263:  QEUE == QEDE*PQEE
264:  LOG(QEDE) = B050110+B050111*LOG(QFDE)+B050112*TREND
265:  DEL(1 : PQEE) = SEE1*DEL(1 : PEEA1)+SEE2*DEL(1 : PEEA2)+SEE3*DEL(1 : PEEA3)
266:  QOUE == QODE*PQOE
267:  LOG(QODE) = B050140+B050141*LOG(QFDE)+B050142*TREND
268:  PQOE = B050150+B050151*(CQEA*PQQA+CQEE*PQQE+CQEQ*PQQQ+CQEK*PQQK+CQEC*PQQC+CQEB*PQQB+CQEZ*PQQZ+CQEL*PQQL+CQEN*PQQN)/(
      CQEA+CQEE+CQEQ+CQEK+CQEC+CQEB+CQEZ+CQEL+CQEN)
269:  LOG(QLDE) = B050160+B050161*LOG(QFDE)+B050163*D8082+B050164*D8388
270:  ITE == ITFE+ITME+ITQE
271:  ITFE*1.6 = CCEC1*ITC1+CCEC2*ITC2+CCEC3*ITC3+CCEC4*ITC4+CCEC5*ITC5+CCEC6*ITC6+CCEC7*ITC7+CCEC8*ITC8+CCEC9*ITC9+CCEC10*
      ITC10+CCEC11*ITC11+CCEC12*ITC12+CCEC13*ITC13+CCEC14*ITC14+CCEC15*ITC15+CGE*ITG+CIRE*ITIR+CIGE*ITIG+CIGE*ITIQ+QSOE/QSOT
      *ITS+QXOE/QVOT*ITX
272:  ITFRE = ITFE/(QYUE-ITFE)
273:  ITQE = B050190+B050191*QFUE+B050192*D74D76
274:  ITME = ITMRE*QMUE/(1+ITMRE)
275:  QYUE = QVUE+ITE
276:  QYDE = QVDE+ITRE75*QFDE
277:  PQYE == QYUE/QYDE
278:  WBE == WRE*NFE
279:  LOG(WRE) = WE0+WE1*LOG(WRT)+WE2*(TREND-1900)
280:  SSFE = SSFRE*WBE/(1+SSFRE)
281:  GOSE == QVUE-WBE
282:  IUE == IDE*PIE
283:  LOG(IDE) = B050330+B050331*LOG(QFDE)+B050332*LOG(PIE)+B050333*LOG(IDE(-1))+B050334*D8192
284:  DEL(1 : LOG(PIE)) = B050350+DEL(1 : LOG(CIQE*PAQ+CIKE*PAK+CICE*PAC+CIBE*PAB+CILE*PAL))+DEL(1 : ITIQR)
285:  NEE == QLDE*PHE/WRE
286:  NFE == NEE
287:  HE = B050400+B050401*HT
288:  PHE = WRE/HE/(WRE75/HE75)
289:  QRE == QRGE
290:  CHE = B050630+B050631*(TREND/1975-1)+B050632*D6772+B050633*D8292
291:  QHUE = (CHEC1*CUC1+CHEC2*CUC2+CHEC3*CUC3+CHEC4*CUC4+CHEC5*CUC5+CHEC6*CUC6+CHEC7*CUC7+CHEC8*CUC8+CHEC9*CUC9+CHEC10*
      CUC10+CHEC11*CUC11+CHEC12*CUC12+CHEC13*CUC13+CHEC14*CUC14+CHEC15*CUC15)*(CHE/0.58)
292:  QHOE = (CHEC1*COC1+CHEC2*COC2+CHEC3*COC3+CHEC4*COC4+CHEC5*COC5+CHEC6*COC6+CHEC7*COC7+CHEC8*COC8+CHEC9*COC9+CHEC10*
      COC10+CHEC11*COC11+CHEC12*COC12+CHEC13*COC13+CHEC14*COC14+CHEC15*COC15)*(CHE/0.58)
293:  PQHE == QHUE/QHOE
294:  QSUE == QGOE*PQGE
295:  QGOE = CGE*(CGO+CNU)
296:  PQSE = PQE
297:  QIUE = (CIEA*IUA+CIEE*IUE+CIEQ*IUQ+CIEK*IUK+CIEC*IUC+CIEB*IUB+CIEZ*IUZ+CIEL*IUL+CIEN*IUN+CIRE*IRU)*1.
298:  QIDE = (CIEA*IOA+CIEE*IOE+CIEQ*IOQ+CIEK*IOK+CIEC*IOC+CIEB*IOB+CIEZ*IOZ+CIEL*IOL+CIEN*ION+CIRE*IRO)*1.
299:  PQIE = QIUE/(QIDE+1.000000E-06)
300:  QSUE == QSOE*PQE
301:  QSOE = B050540+B050541*QFDE
302:  PQSE == PQE
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303:   QXUE == QXQE*PQXE

304:   LOG(QXQE) = B050570+B050571*LOG(QFQE)+B050572*LOG(PQFE*KRKURS)+B050573*(TREND-1900)-B050573/2*(TREND-1988)*D8800+
       B050574*D7276+B050575*D7881

305:   PQXE = PXE*EX/EXO

306:   CQE = B050620+B050621*(TREND/1975-1)+B050622*D6680

307:   QQUE == QQQE*PQQE

308:   QQQE = (CEA*QEQA+CEE*QEQE+CEQ*QEQQ+CEK*QEQK+CEC*QEQC+CEB*QEQB+CEZ*QEQZ+CEL*QEQL+CEN*QEQN)*(CQE/0.349573)

309:   LOG(PQQE) = B050610+B050611*LOG(PQFE)+(1-B050611)*LOG(PQME)+B050612*D6680

310:   QMUE == QMQE*PQME

311:   QMQE = QQQE/CQE-QQQE+QHQE/CHE-QHQE+IMEXUE/PQME

312:   PQME = PME*EX/EXO

313:   LOG(PBE) = B050750+B050751*LOG(PQEE)+B050752*LOG(PQQE)+B050754*D8383

314:   PAE = PQFE

315:   SWE == QXUE-QMUE

316:   SWRE == SWE/QXUE

317:   PXMRE == PQXE/PQME

318:   QUQ == QFUQ+ITFQ

319:   QQQ == QFQQ+ITFRQ75*QFQQ

320:   PQQ == QUQ/QQQ

321:   QFUQ == QFQQ*PQFQ

322:   QFQQ = QQQQ+QHQQ+QGQQ+QIQQ+QSQQ+QXQQ

323:   LOG(PQFQ) = B060060+B060061*LOG(PBQ)+B060062*LOG(PQMQ)+B060063*D8288+0.04*D8492

324:   QVUQ == QFUQ-QEUQ-QQUQ-ITQQ

325:   QVQQ == QFQQ-QEQQ-QQQQ-ITQRQ75*QFQQ

326:   PQVQ == QVUQ/QVQQ

327:   QEUQ == QEQQ*PQEQ

328:   PQEQ = B060120+B060121*(SQE1*PEQA1+SQE2*PEQA2+SQE3*PEQA3)

329:   QQUQ == QQQQ*PQQQ

330:   PQQQ = B060150+B060151*(CQQA*PQQA+CQQE*PQQE+CQQQ*PQQQ+CQQK*PQQK+CQQC*PQQC+CQQB*PQQB+CQQZ*PQQZ+CQQL*PQQL+CQQN*PQQN)/(
       CQQA+CQQE+CQQQ+CQQK+CQQC+CQQB+CQQZ+CQQL+CQQN)

331:   ITQ == ITFQ+ITMQ+ITQQ

332:   ITFQ*0.65 = CCQC1*ITC1+CCQC2*ITC2+CCQC3*ITC3+CCQC4*ITC4+CCQC5*ITC5+CCQC6*ITC6+CCQC7*ITC7+CCQC8*ITC8+CCQC9*ITC9+CCQC10*
       ITC10+CCQC11*ITC11+CCQC12*ITC12+CCQC13*ITC13+CCQC14*ITC14+CCQC15*ITC15+CGQ*ITG+CIRQ*ITIR+CIGQ*ITIG+CIGQ*ITIQ+QSQQ/QSQT
       *ITS+QXQQ/QVQT*ITX

333:   ITFRQ = ITFQ/(QYUQ-ITFQ)

334:   ITQQ = B060190+B060191*QFUQ+B060192*D74D76

335:   ITMQ == ITMRQ*QMUQ/(1+ITMRQ)

336:   QYUQ == QVUQ+ITQ

337:   QYQQ = QVQQ+ITRQ75*QFQQ

338:   PQYQ == QYUQ/QYQQ

339:   WBQ == WSQ*NFQ

340:   LOG(WRQ) = WQ0+WQ1*LOG(WRT)+WQ2*(TREND-1900)

341:   SSFQ == SSFRQ*WBQ/(1+SSFRQ)

342:   GOSQ == QVUQ-WBQ

343:   IUQ == IQQ*PIQ

344:   LOG(PIQ) = B060350+B060351*(CIQQ*LOG(PAQ)+CIKQ*LOG(PAK)+CICQ*LOG(PAC)+CIBQ*LOG(PAB)+CILQ*LOG(PIL))*((1+ITIQR)/(1+
       ITIQR75))
```

```
345:   NQ = NFQ+NIQ
346:   LOG(NIQ) = NQ1+NQ2*LOG(QFDQ)+NQ3*(TREND-1900)
347:   HQ = B060410+B060411*HT
348:   PHQ = WRQ/HQ/(WRQ75/HQ75)
349:   CHQ = B060630+B060631*(TREND/1975-1)+B060632*D7179+B060633*D8183
350:   QHUQ = (CHQC1*CUC1+CHQC2*CUC2+CHQC3*CUC3+CHQC4*CUC4+CHQC5*CUC5+CHQC6*CUC6+CHQC7*CUC7+CHQC8*CUC8+CHQC9*CUC9+CHQC10*
       CUC10+CHQC11*CUC11+CHQC12*CUC12+CHQC13*CUC13+CHQC14*CUC14+CHQC15*CUC15)*(CHQ/0.623355)
351:   QHDQ = (CHQC1*CDC1+CHQC2*CDC2+CHQC3*CDC3+CHQC4*CDC4+CHQC5*CDC5+CHQC6*CDC6+CHQC7*CDC7+CHQC8*CDC8+CHQC9*CDC9+CHQC10*
       CDC10+CHQC11*CDC11+CHQC12*CDC12+CHQC13*CDC13+CHQC14*CDC14+CHQC15*CDC15)*(CHQ/0.623355)
352:   PQHQ == QHUQ/QHDQ
353:   QGUQ == QGDQ*PQGQ
354:   QGDQ = CGQ*(CSO+CNU)
355:   PQGQ = PQQ
356:   CIQ = B060640+B060641*(TREND/1975-1)+B060642*D6672
357:   QIUQ = (CIQA*IUA+CIQE*IUE+CIQQ*IUQ+CIQK*IUK+CIQC*IUC+CIQB*IUB+CIQZ*IUZ+CIQL*IUL+CIQN*IUN+CIRQ*IRU)*CIQ
358:   QIDQ = (CIQA*IDA+CIQE*IDE+CIQQ*IDQ+CIQK*IDK+CIQC*IDC+CIQB*IDB+CIQZ*IDZ+CIQL*IDL+CIQN*IDN+CIRQ*IRD)*CIQ
359:   PQIQ == QIUQ/QIDQ
360:   QSUQ = QSDQ*PQQ
361:   QSDQ = B060540+B060541*QFDQ
362:   PQSQ == PQQ
363:   QXUQ == QXDQ*PQXQ
364:   LOG(QXDQ) = B060570+B060571*LOG(QPQ)+B060572*LOG(PQFQ*KRKURS)+B060573*(TREND-1900)-B060573/4*(TREND-1988)*D8800-0.15*
       D8592
365:   PQXQ = PXQ*EX/EXO
366:   CQQ = B060620+B060621*(TREND/1975-1)+B060622*D7579
367:   QQUQ == QQDQ*PQQQ
368:   QQDQ = (CQAQ*QQDA+CQEQ*QQDE+CQQQ*QQDQ+CQKQ*QQDK+CQCQ*QQDC+CQBQ*QQDB+CQZQ*QQDZ+CQLQ*QQDL+CQNQ*QQDN)*(CQQ/0.508078)
369:   PQQQ = PAQ
370:   QMUQ == QMDQ*PQMQ
371:   QMDQ = QQDQ/CQQ-QQDQ+QHDQ/CHQ-QHDQ+IMEXUQ/PQMQ
372:   PQMQ = PMQ*EX/EXO
373:   LOG(PBQ) = B060750+B060751*LOG(PQEQ)+B060752*LOG(PQQQ)+B060753*LOG(WRQ/0.06822)
374:   PAQ = PQFQ
375:   SWQ == QXUQ-QMUQ
376:   SWRQ == SWQ/QXUQ
377:   PXMRQ == PQXQ/PQMQ
378:   QUK == QFUK+ITFK
379:   QDK == QFDK+ITFRK75*QFDK
380:   PQK == QUK/QDK
381:   QFUK == QFDK*PQFK
382:   QFDK = QQDK+QHDK+QGDK+QIDK+QSDK+QXDK
383:   LOG(PQFK) = B070060+B070061*LOG(PBK)+B070062*LOG(PQMK)+0.03*D8585+0.07*D8692
384:   QVUK == QFUK-QEUK-QQUK-ITQK
385:   QVDK == QFDK-QEDK-QQDK-ITQRK75*QFDK
386:   PQVK == QVUK/QVDK
387:   QEUK == QEDK*PQEK
```

```
388:  PQEK = B070120*(SKE1*PEKA1+SKE2*PEKA2+SKE3*PEKA3)

389:  QOUK == QOOK*PQOK

390:  PQOK = (CQKA*PQQA+CQKE*PQQE+CQKQ*PQQQ+CQKK*PQQK+CQKC*PQQC+CQKB*PQQB+CQKZ*PQQZ+CQKL*PQQL+CQKN*PQQN)/(CQKA+CQKE+CQKQ+
      CQKK+CQKC+CQKB+CQKZ+CQKL+CQKN)

391:  ITK == ITFK+ITMK+ITQK

392:  ITFK*1.3 = CCKC1*ITC1+CCKC2*ITC2+CCKC3*ITC3+CCKC4*ITC4+CCKC5*ITC5+CCKC6*ITC6+CCKC7*ITC7+CCKC8*ITC8+CCKC9*ITC9+CCKC10*
      ITC10+CCKC11*ITC11+CCKC12*ITC12+CCKC13*ITC13+CCKC14*ITC14+CCKC15*ITC15+CGK*ITG+CIRK*ITIR+CIGK*ITIG+CIGK*ITIQ+QSOK/QSOT
      *ITS+QXOK/QVOT*ITX

393:  ITFRK = ITFK/(QYUK-ITFK)

394:  ITQK = B070190+B070191*QFUK+B070192*D74D76

395:  ITMK == ITMRK*QMUK/(1+ITMRK)

396:  QYUK == QVUK+ITK

397:  QYOK = QVOK+ITRK75*QFOK

398:  PQYK == QYUK/QYOK

399:  WBK == WRK*NFK

400:  LOG(WRK) = WK0+WK1*LOG(WRT)+WK2*(TREND-1900)

401:  SSFK == SSFRK*WBK/(1+SSFRK)

402:  BOSK == QVUK-WBK

403:  IUK == IOK*PIK

404:  LOG(PIK) = B070350+B070351*(CIQK*LOG(PAQ)+CIKK*LOG(PAK)+CICK*LOG(PAC)+CIBK*LOG(PAB)+CILK*LOG(PAL))*((1+ITIQR)/(1+
      ITIQR75))

405:  NK = NFK+NIK

406:  LOG(NIK) = NK1+NK2*LOG(QFOK)+NK3*(TREND-1900)

407:  HK = B070410+B070411*HT

408:  PHK = WRK/HK/(WRK75/HK75)

409:  CHK = B070630+B070631*(TREND/1975-1)+B070632*D7378+B070633*D8081

410:  QHUK = (CHKC1*CUC1+CHKC2*CUC2+CHKC3*CUC3+CHKC4*CUC4+CHKC5*CUC5+CHKC6*CUC6+CHKC7*CUC7+CHKC8*CUC8+CHKC9*CUC9+CHKC10*
      CUC10+CHKC11*CUC11+CHKC12*CUC12+CHKC13*CUC13+CHKC14*CUC14+CHKC15*CUC15)*(CHK/0.300296)

411:  QHOK = (CHKC1*COC1+CHKC2*COC2+CHKC3*COC3+CHKC4*COC4+CHKC5*COC5+CHKC6*COC6+CHKC7*COC7+CHKC8*COC8+CHKC9*COC9+CHKC10*
      COC10+CHKC11*COC11+CHKC12*COC12+CHKC13*COC13+CHKC14*COC14+CHKC15*COC15)*(CHK/0.300296)

412:  PQHK == QHUK/QHOK

413:  QSUK == QSOK*PQSK

414:  QGOK = CGK*(CGO+CNU)

415:  PQGK = PQK

416:  CIK = B070640+B070641*(TREND/1975-1)+B070642*D7376

417:  QIUK = (CIKA*IUA+CIKE*IUE+CIKQ*IUQ+CIKK*IUK+CIKC*IUC+CIKB*IUB+CIKZ*IUZ+CIKL*IUL+CIKN*IUN+CIRK*IRU)*CIK

418:  QIOK = (CIKA*IOA+CIKE*IOE+CIKQ*IOQ+CIKK*IOK+CIKC*IOC+CIKB*IOB+CIKZ*IOZ+CIKL*IOL+CIKN*ION+CIRK*IRO)*CIK

419:  PQIK == QIUK/QIOK

420:  QSUK = QSOK*PQK

421:  QSOK = B070540+B070541*QFOK

422:  PQSK == PQK

423:  QXUK == QXOK*PQXK

424:  LOG(QXOK) = B070570+B070571*LOG(QFOK)+B070572*LOG(PQFK*KRKURS)+B070573*(TREND-1900)-B070573/2*(TREND-1988)*D8800-0.1*
      D8592

425:  PQXK = PXK*EX/EXO

426:  CQK = B070620+B070621*(TREND/1975-1)

427:  QQUK == QQOK*PQQK

428:  QQOK = (CQAK*QOOA+CQEK*QOOE+CQQK*QOOQ+CQKK*QOOK+CQCK*QOOC+CQBK*QOOB+CQZK*QOOZ+CQLK*QOOL+CQNK*QOON)*(CQK/0.535648)
```

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429:  PQQK = PAK
430:  QMUK == QMOK*PQMK
431:  QMOK = QQOK/CQK-QQOK+QHOK/CHK-QHOK+QIOK/CIK-QIOK+IMEXUK/PQMK
432:  PQMK = PMK*EX/EXO
433:  LOG(PBK) = B070750+B070751*LOG(PQEK)+B070752*LOG(PQOK)+B070753*LOG(WRK/0.0632)
434:  PAK = PQFK
435:  SWK == QXUK-QMUK
436:  SWRK == SWK/QXUK
437:  PXMRK == PQXK/PQMK
438:  QUC == QFUC+ITFC
439:  QOC == QFOC+ITFRC75*QFOC
440:  PQC == QUC/QOC
441:  QFUC == QFOC*PQFC
442:  QFOC = QQOC+QHOC+QGOC+QIOC+QSOC+QXOC
443:  LOG(PQFC) = B080060+B080061*LOG(PBC)+0.02*D8485+0.03*D8692
444:  QVUC == QFUC-QEUC-QOUC-ITQC
445:  QVOC == QFOC-QEOC-QOOC-ITQRC75*QFOC
446:  PQVC == QVUC/QVOC
447:  QEUC == QEOC*PQEC
448:  DEL(1 : PQEC) = SCE1*DEL(1 : PECA1)+SCE2*DEL(1 : PECA2)+SCE3*DEL(1 : PECA3)
449:  QOUC == QOOC*PQOC
450:  PQOC = (CQCA*PQQA+CQCE*PQQE+CQCQ*PQQQ+CQCK*PQQK+CQCC*PQQC+CQCB*PQQB+CQCZ*PQQZ+CQCL*PQQL+CQCN*PQQN)/(CQCA+CQCE+CQCQ+
      CQCK+CQCC+CQCB+CQCZ+CQCL+CQCN)
451:  ITC == ITFC+ITMC+ITQC
452:  ITFC*1.4 = CCCC1*ITC1+CCCC2*ITC2+CCCC3*ITC3+CCCC4*ITC4+CCCC5*ITC5+CCCC6*ITC6+CCCC7*ITC7+CCCC8*ITC8+CCCC9*ITC9+CCCC10*
      ITC10+CCCC11*ITC11+CCCC12*ITC12+CCCC13*ITC13+CCCC14*ITC14+CCCC15*ITC15+CBC*ITB+CIRC*ITIR+CIGC*ITIG+CIGC*ITIQ+QSOC/QSOT
      *ITS+QXOC/QVOT*ITX
453:  ITFRC = ITFC/(QYUC-ITFC)
454:  ITQC = B080190+B080191*QFUC+B080192*D74D76
455:  ITMC == ITMRC*QMUC/(1+ITMRC)
456:  QYUC == QVUC+ITC
457:  QYOC = QVOC+ITRC75*QFOC
458:  PQYC == QYUC/QYOC
459:  WBC == WRC*NFC
460:  LOG(WRC) = WC0+WC1*LOG(WRT)+WC2*(TREND-1900)
461:  SSFC == SSFRC*WBC/(1+SSFRC)
462:  GOSC == QVUC-WBC
463:  IUC == IOC*PIC
464:  LOG(PIC) = B080350+B080351*(CIQC*LOG(PAQ)+CIKC*LOG(PAK)+CICC*LOG(PAC)+CIBC*LOG(PAB)+CILC*LOG(PAL))*((1+ITIQR)/(1+
      ITIQR75))
465:  NC = NFC+NIC
466:  LOG(NIC) = NC1+NC2*LOG(NC)+NC3*(TREND-1900)
467:  HC = B080410+B080411*HT
468:  PHC = WRC/HC/(WRC75/HC75)
469:  CHC = B080630+B080631*(TREND/1975-1)-0.034*D8392
470:  QHUC = (CHCC1*CUC1+CHCC2*CUC2+CHCC3*CUC3+CHCC4*CUC4+CHCC5*CUC5+CHCC6*CUC6+CHCC7*CUC7+CHCC8*CUC8+CHCC9*CUC9+CHCC10*
      CUC10+CHCC11*CUC11+CHCC12*CUC12+CHCC13*CUC13+CHCC14*CUC14+CHCC15*CUC15)*(CHC/0.819646)
```

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471:  QHOC = (CHCC1*COC1+CHCC2*COC2+CHCC3*COC3+CHCC4*COC4+CHCC5*COC5+CHCC6*COC6+CHCC7*COC7+CHCC8*COC8+CHCC9*COC9+CHCC10*
      COC10+CHCC11*COC11+CHCC12*COC12+CHCC13*COC13+CHCC14*COC14+CHCC15*COC15)*(CHC/0.819646)

472:  PQHC == QHUC/QHOC

473:  QBUC == QBOC*PQBC

474:  QGOC = CGC*(CGO+CNU)

475:  PQGC = PQC

476:  CIC = B080640+B080641*(TREND/1975-1)

477:  QIUC = (CICA*IUA+CICE*IUE+CICQ*IUQ+CICK*IUK+CICC*IUC+CICB*IUB+CICZ*IUZ+CICL*IUL+CICN*IUN+CIRC*IRU)*CIC

478:  QIOC = (CICA*IOA+CICE*IOE+CICQ*IOQ+CICK*IOK+CICC*IOC+CICB*IOB+CICZ*IOZ+CICL*IOL+CICN*ION+CIRC*IRO)*CIC

479:  PQIC == QIUC/QIOC

480:  QSUC = QSOC*PQC

481:  QSOC = B080540+B080541*QFDC

482:  PQSC == PQC

483:  QXUC == QXOC*PQXC

484:  LOG(QXOC) = B080570+B080571*LOG(QFC)+B080572*LOG(PQFC*KRKURS)+B080573*(TREND-1900)-B080573/2*(TREND-1988)*D8800-0.1*
      D8592

485:  PQXC = PXC*EX/EXO

486:  CQC = B080620+B080621*(TREND/1975-1)

487:  QQUC == QQOC*PQQC

488:  QQOC = (CQAC*QQOA+CQEC*QQOE+CQQC*QQOQ+CQKC*QQOK+CQCC*QQOC+CQBC*QQOB+CQZC*QQOZ+CQLC*QQOL+CQNC*QQON)*(CQC/0.69539)

489:  PQQC = PAC

490:  QMUC == QMOC*PQMC

491:  QMOC = QQOC/CQC-QQOC+QHOC/CHC-QHOC+IMEXUC/PQMC

492:  PQMC = PMC*EX/EXO

493:  LOG(PBC) = B080750+B080751*LOG(PQEC)+B080752*LOG(PQDC)+B080753*LOG(WRC/0.0596)

494:  PAC = PQFC

495:  SWC == QXUC-QMUC

496:  SWRC == SWC/QXUC

497:  PXMRC == PQXC/PQMC

498:  QUB == QFUB+ITFB

499:  QOB == QFOB+ITFRB75*QFOB

500:  PQB == QUB/QOB

501:  QFUB == QFOB*PQFB

502:  QFOB = QQOB+QHOB+QGOB+QIOB

503:  LOG(PQFB) = B090060+B090061*LOG(PBB)+B090062*D7575+0.03*DS284+0.04*D8592

504:  QVUB == QFUB-QEUB-QOUB-ITQB

505:  QVOB == QFOB-QEOB-QOOB-ITQRB75*QFOB

506:  PQVB == QVUB/QVOB

507:  QEUB == QEOB*PQEB

508:  LOG(QEOB) = B090110+B090112*LOG(QFOB)

509:  PQEB = B040120+B040121*(0.84*PEBA2+0.16*PEBA3)

510:  QOUB == QOOB*PQOB

511:  LOG(QOOB) = B090140+B090141*LOG(QFOB)+B090142*TREND

512:  PQOB = (CQBA*PQQA+CQBE*PQQE+CQBQ*PQQQ+CQBK*PQQK+CQBC*PQQC+CQBB*PQQB+CQBZ*PQQZ+CQBL*PQQL+CQBN*PQQN)/(CQBA+CQBE+CQBQ+
      CQBK+CQBC+CQBB+CQBZ+CQBL+CQBN)

513:  LOG(QLOB) = B090160+B090161*LOG(QFOB)+B090162*LOG(WRB/0.06913)+B090163*D7880
```

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514:  ITB == ITFB+ITQB

515:  ITFB*1.2 = CCBC1*ITC1+CCBC2*ITC2+CCBC3*ITC3+CCBC4*ITC4+CCBC5*ITC5+CCBC6*ITC6+CCBC7*ITC7+CCBC8*ITC8+CCBC9*ITC9+CCBC10*
      ITC10+CCBC11*ITC11+CCBC12*ITC12+CCBC13*ITC13+CCBC14*ITC14+CCBC15*ITC15+CGB*ITG+CIRB*ITIR+CIGB*ITIG+CIGB*ITIQ

516:  ITFRB = ITFB/(QYUB-ITFB)

517:  ITQB = B090190+B090191*QFUB+B090192*D74D76

518:  QYUB == QVUB+ITB

519:  QYOB = QVOB+ITRB75*QFOB

520:  PQYB == QYUB/QYOB

521:  WBB == WRB*NFB

522:  LOG(WRB) = WB0+WB1*LOG(WRT)+WB2*(TREND-1900)

523:  SSFB == SSFRB*WBB/(1+SSFRB)

524:  GOSB == QVUB-WBB

525:  IUB == IOB*PIB

526:  LOG(IOB) = B090340+B090341*LOG(QFOB)+(+B090343)*LOG(IOB(-1))+0.31*D85B6

527:  LOG(PIB) = B090350+B090351*(CIQB*LOG(PAQ)+CIKB*LOG(PAK)+CICB*LOG(PAC)+CIBB*LOG(PAB)+CILB*LOG(PAL))*((1+ITIQR)/(1+
      ITIQR75))

528:  NB = NFB+NIB

529:  LOG(NFB) = NB0+NB1*LOG(QFOB)+NB2*(TREND-1900)

530:  LOG(NIB) = NB3+NB4*LOG(QFOB)+NB5*(TREND-1900)+NB6*D77B1

531:  HB = B090410+B090411*HT

532:  PHB = WRB/HB/(WRB75/HB75)

533:  QHUB = CHBC1*CUC1+CHBC2*CUC2+CHBC3*CUC3+CHBC4*CUC4+CHBC5*CUC5+CHBC6*CUC6+CHBC7*CUC7+CHBC8*CUCB+CHBC9*CUC9+CHBC10*CUC10
      +CHBC11*CUC11+CHBC12*CUC12+CHBC13*CUC13+CHBC14*CUC14+CHBC15*CUC15

534:  QHOB = CHBC1*COC1+CHBC2*COC2+CHBC3*COC3+CHBC4*COC4+CHBC5*COC5+CHBC6*COC6+CHBC7*COC7+CHBC8*COCB+CHBC9*COC9+CHBC10*COC10
      +CHBC11*COC11+CHBC12*COC12+CHBC13*COC13+CHBC14*COC14+CHBC15*COC15+1.000000E-06

535:  PQHB == QHUB/QHOB

536:  QGUB == QGOB*PQGB

537:  QGOB = CGB*(CGO+CNU)

538:  PQGB = PQB

539:  QIUB = (CIBA*IUA+CIBE*IUE+CIBQ*IUQ+CIBK*IUK+CIBC*IUC+CIBB*IUB+CIBZ*IUZ+CIBL*IUL+CIBN*IUN+CIRB*CORIB*IRU)*1*0.+(IUA+IUE
      +IUQ+IUK+IUC+IUB+IUZ+IUL+IUN+IRU)*CIB*0+IU*CILEVB

540:  QIOB = (CIBA*IOA+CIBE*IOE+CIBQ*IOQ+CIBK*IOK+CIBC*IOC+CIBB*IOB+CIBZ*IOZ+CIBL*IOL+CIBN*ION+CIRB*CORIB*IRO)*1*0.+(IOA+IOE
      +IOQ+IOK+IOC+IOB+IOZ+IOL+ION+IRO)*CIB*0+IO*CILEVB

541:  PQIB == QIUB/QIOB

542:  QQUB == QQOB*PQQB

543:  QQOB = CQAB*QQOA+CQEB*QQOE+CQQB*QQOQ+CQKB*QQOK+CQCB*QQOC+CQBB*QQOB+CQZB*QQOZ+CQLB*QQOL+CQNB*QQON

544:  PQQB = PAB

545:  LOG(PBB) = B090750+B090751*LOG(PQEB)+B090752*LOG(PQQB)+B090753*LOG(WRB/0.06913)

546:  PAB = PQFB

547:  QUZ == QFUZ+ITFZ

548:  QOZ == QFOZ+ITFRZ75*QFOZ

549:  PQZ == QUZ/QOZ

550:  QFUZ == QFOZ*PQFZ

551:  QFOZ = QQOZ+QHOZ+QGOZ+QIOZ+QXOZ

552:  LOG(PQFZ) = B100060+B100061*LOG(PBZ)+0.03*D83B4

553:  QVUZ == QFUZ-QEUZ-QQUZ-ITQZ

554:  QVOZ == QFOZ-QEOZ-QQOZ-ITQRZ75*QFOZ

555:  PQVZ == QVUZ/QVOZ
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556:  QEUZ == QEDZ*PQEZ

557:  LOG(QEDZ) = B100110+B100111*LOG(QFDZ)+B100112*TREND

558:  PQEZ = B100120*(0.95*PEZA2+0.05*PEZA3)

559:  QDUZ == QDDZ*PQDZ

560:  LOG(QDDZ) = B100140+B100141*LOG(QFDZ)+B100142*TREND

561:  PQDZ = B100150+B100151*(CQZA*PQQA+CQZE*PQQE+CQZQ*PQQQ+CQZK*PQQK+CQZC*PQQC+CQZB*PQQB+CQZZ*PQQZ+CQZL*PQQL+CQZN*PQQN)/(
      CQZA+CQZE+CQZQ+CQZK+CQZC+CQZB+CQZZ+CQZL+CQZN)

562:  LOG(QLDZ) = B100160+B100161*LOG(QFDZ)+B100162*TREND+B100163*(WRZ/0.065798)+B100164*D8588

563:  ITZ == ITFZ+ITQZ

564:  ITFZ*0.4 = CCZC1*ITC1+CCZC2*ITC2+CCZC3*ITC3+CCZC4*ITC4+CCZC5*ITC5+CCZC6*ITC6+CCZC7*ITC7+CCZC8*ITC8+CCZC9*ITC9+CCZC10*
      ITC10+CCZC11*ITC11+CCZC12*ITC12+CCZC13*ITC13+CCZC14*ITC14+CCZC15*ITC15+CSZ*ITG+CIRZ*ITIR+CIGZ*ITIG+CIGZ*ITIQ+QXDZ/QVDT
      *ITX

565:  ITFRZ = ITFZ/(QYUZ-ITFZ)

566:  ITQZ = B100190+B100191*QFUZ+B100192*D74D76

567:  QYUZ == QVUZ+ITZ

568:  QYDZ = QVDZ+ITRZ75*QFDZ

569:  PQYZ == QYUZ/QYDZ

570:  WBZ == WRZ*NFZ

571:  LOG(WRZ) = WZ0+WZ1*LOG(WRT)+WZ2*(TREND-1900)

572:  SSFZ == SSFRZ*WBZ/(1+SSFRZ)

573:  GOSZ == QVUZ-WBZ

574:  IUZ == IDZ*PIZ

575:  LOG(IDZ) = B100340+B100341*LOG(QFDZ)+B100342*LOG(PIZ)+B100344*D7678+B100345*D8282+0.25*D8586

576:  LOG(PIZ) = B100350+B100351*(CIQZ*LOG(PAQ)+CIKZ*LOG(PAK)+CICZ*LOG(PAC)+CIBZ*LOG(PAB)+CILZ*LOG(PAL))*((1+ITIQR)/(1+
      ITIQR75))

577:  NZ = NFZ+NIZ

578:  LOG(NFZ) = NZ0+NZ1*LOG(QFDZ)+NZ2*(TREND-1900)+0.02*D8692

579:  LOG(NIZ) = NZ3+NZ4*LOG(QFDZ)+NZ5*(TREND-1900)

580:  HZ = B100410+B100411*HT

581:  PHZ = WRZ/HZ/(WRZ75/HZ75)

582:  QHUZ = CHZC1*CUC1+CHZC2*CUC2+CHZC3*CUC3+CHZC4*CUC4+CHZC5*CUC5+CHZC6*CUC6+CHZC7*CUC7+CHZC8*CUC8+CHZC9*CUC9+CHZC10*CUC10
      +CHZC11*CUC11+CHZC12*CUC12+CHZC13*CUC13+CHZC14*CUC14+CHZC15*CUC15

583:  QHDZ = CHZC1*CDC1+CHZC2*CDC2+CHZC3*CDC3+CHZC4*CDC4+CHZC5*CDC5+CHZC6*CDC6+CHZC7*CDC7+CHZC8*CDC8+CHZC9*CDC9+CHZC10*CDC10
      +CHZC11*CDC11+CHZC12*CDC12+CHZC13*CDC13+CHZC14*CDC14+CHZC15*CDC15

584:  PQHZ == QHUZ/QHDZ

585:  QGUZ == QGDZ*PQGZ

586:  QGDZ = CGZ*(CGO+CNU)

587:  PQGZ = PQZ

588:  QIUZ = (CIZA*IUA+CIZE*IUE+CIZQ*IUQ+CIZK*IUK+CIZC*IUC+CIZB*IUB+CIZZ*IUZ+CIZL*IUL+CIZN*IUN+CIRZ*IRU)*1.

589:  QIDZ = (CIZA*IDA+CIZE*IDE+CIZQ*IDQ+CIZK*IDK+CIZC*IDC+CIZB*IDB+CIZZ*IDZ+CIZL*IDL+CIZN*IDN+CIRZ*IRD)*1.+1,000000E-06

590:  PQIZ == QIUZ/QIDZ

591:  QXUZ == QXDZ*PQXZ

592:  LOG(QXDZ) = B100570+B100571*LOG(QFDZ)+B100572*LOG(PQFZ*KRKURS)+B100573*(TREND-1900)+B100574*D8392+0.09*D8392-0.1*D8092

593:  PQXZ = PXZ*EX/EXD

594:  QQUZ == QQDZ*PQQZ

595:  QQDZ = CQAZ*QDDA+CQEZ*QDDE+CQQZ*QDDQ+CQKZ*QDDK+CQCZ*QDDC+CQBZ*QDDB+CQZZ*QDDZ+CQLZ*QDDL+CQNZ*QDDN

596:  PQQZ = PAZ
```

```
597:  LOG(PBZ) = B100750+B100751*LOG(PQEZ)+B100752*LOG(PBOZ)+B100753*LOG(WRZ/0.0658)
598:  PAZ = PQFZ
599:  SWZ == QXUZ
600:  SWRZ == SWZ/QXUZ
601:  PXMRZ == PQXZ/PQZ
602:  QUL == QFUL+ITFL
603:  QOL == QFOL+ITFRL75*QFOL
604:  PQL == QUL/QOL
605:  QFUL == QFOL*PQFL
606:  QFOL = QQOL+QHOL+QSOL+QIOL+QSOL+QXOL+QYOI
607:  LOG(PQFL) = B110060+B110061*LOG(PBL)+B110062*LOG(PQML)+B110063*D8081+0.04*D8492
608:  QVUL == QFUL-QEUL-QOUL-ITQL
609:  QVOL == QFOL-QEOL-QOOL-ITQRL75*QFOL
610:  PQVL == QVUL/QVOL
611:  QEUL == QEOL*PQEL
612:  LOG(QEOL) = B110110+B110111*LOG(QFOL)+B110112*LOG(PQEL)
613:  PQEL = B110120+B110121*(0.4*PELA1+0.15*PELA2+0.45*PELA3)
614:  QOUL == QOOL*PQOL
615:  LOG(QOOL) = B110140+B110141*LOG(QFOL)
616:  PQOL = (CQLA*PQQA+CQLE*PQQE+CQLQ*PQQQ+CQLK*PQQK+CQLC*PQQC+CQLB*PQQB+CQLZ*PQQZ+CQLL*PQQL+CQLN*PQQN)/(CQLA+CQLE+CQLQ+
      CQLK+CQLC+CQLB+CQLZ+CQLL+CQLN)
617:  LOG(QLOL) = B110160+B110161*LOG(QFOL)+B110162*TREND+B110163*D7880+B110164*D8588
618:  ITL == ITFL+ITML+ITQL
619:  ITFL*1.4 = CCLC1*ITC1+CCLC2*ITC2+CCLC3*ITC3+CCLC4*ITC4+CCLC5*ITC5+CCLC6*ITC6+CCLC7*ITC7+CCLC8*ITC8+CCLC9*ITC9+CCLC10*
      ITC10+CCLC11*ITC11+CCLC12*ITC12+CCLC13*ITC13+CCLC14*ITC14+CCLC15*ITC15+CGL*ITG+CIRL*ITIR+CIGL*ITIG+CIQL*ITIQ+QSOL/QSOT
      *ITS+QXOL/QVOT*ITX
620:  ITFRL = ITFL/(QYUL-ITFL)
621:  ITQL = B110190+B110191*QFUL+B110192*D74D76
622:  ITML == ITMRL*QMUL/(1+ITMRL)
623:  QYUL == QVUL+ITL
624:  QYOL = QVOL+ITRL75*QFOL
625:  PQYL == QYUL/QYOL
626:  WBL == WRL*NFL
627:  LOG(WRL) = WL0+WL1*LOG(WRT)+WL2*(TREND-1900)
628:  SSFL == SSFRL*WBL/(1+SSFRL)
629:  GOSL == QVUL-WBL
630:  IUL == IOL*PIL
631:  LOG(IOL) = B110340+B110341*LOG(QFOL)+B110342*LOG(PIL)+B110344*D8182+0.3*D8486+0.2*D8792
632:  LOG(PIL) = B110350+B110351*(CIQL*LOG(PAQ)+CIKL*LOG(PAK)+CICL*LOG(PAC)+CIBL*LOG(PAB)+CILL*LOG(PAL))*((1+ITIQR)/(1+
      ITIQR75))
633:  NL = NFL+NIL
634:  LOG(NFL) = NL0+NL1*LOG(QFOL)+NL2*(TREND-1900)+NL3*D8384+0.03*D8692
635:  LOG(NIL) = NL4+NL5*LOG(QFOL)+NL6*(TREND-1900)
636:  HL = B110410+B110411*HT
637:  PHL = WRL/HL/(WRL75/HL75)
638:  QHUL = CHLC1*CUC1+CHLC2*CUC2+CHLC3*CUC3+CHLC4*CUC4+CHLC5*CUC5+CHLC6*CUC6+CHLC7*CUC7+CHLC8*CUC8+CHLC9*CUC9+CHLC10*CUC10
      +CHLC11*CUC11+CHLC12*CUC12+CHLC13*CUC13+CHLC14*CUC14+CHLC15*CUC15
```

```
639:  QHOL = CHLC1*COC1+CHLC2*COC2+CHLC3*COC3+CHLC4*COC4+CHLC5*COC5+CHLC6*COC6+CHLC7*COC7+CHLC8*COC8+CHLC9*COC9+CHLC10*COC10
      +CHLC11*COC11+CHLC12*COC12+CHLC13*COC13+CHLC14*COC14+CHLC15*COC15

640:  PQHL == QHUL/QHOL

641:  QGUL == QGOL*PQGL

642:  QGOL = CGL*(CGO+CNU)

643:  PQGL = PQL

644:  QIUL = (CILA*IUA+CILE*IUE+CILQ*IUQ+CILK*IUK+CILC*IUC+CILB*IUB+CILZ*IUZ+CILL*IUL+CILN*IUN+CIRL*IRU)*1.*0.+(IUA+IUE+IUQ+
      IUK+IUC+IUB+IUZ+IUL+IUN+IRU)*CIL

645:  QIOL = (CILA*IOA+CILE*IOE+CILQ*IOQ+CILK*IOK+CILC*IOC+CILB*IOB+CILZ*IOZ+CILL*IOL+CILN*ION+CIRL*IRO)*1.*0.+(IOA+IOE+IOQ+
      IOK+IOC+IOB+IOZ+IOL+ION+IRO)*CIL

646:  PQIL == QIUL/QIOL

647:  QSUL = QSOL*PQL

648:  QSOL = B110540+B110541*QFOL

649:  PQSL == PQL

650:  QXUL == QXOL*PQXL

651:  LOG(QXOL) = B110570+B110571*LOG(QFOL)+B110572*LOG(PQFL*KRKURS)+B110573*(TREND-1900)+B110574*D7077+B110575*D8392

652:  PQXL = PXL*EX/EXO

653:  CQL = 1.

654:  QQUL == QQOL*PQQL

655:  QQOL = (CQAL*QOOA+CQEL*QOOE+CQQL*QOOQ+CQKL*QOOK+CQCL*QOOC+CQBL*QOOB+CQZL*QOOZ+CQLL*QOOL+CQNL*QOON)*((CQL-0.08*D7585)/
      0.9)

656:  PQQL = PAL

657:  QMUL == QMOL*PQML

658:  QMOL = QQOL/CQL-QQOL+IMEXUL/PQML

659:  PQML = PML*EX/EXO

660:  LOG(PBL) = B110750+B110752*LOG(PQQL)+B110753*LOG(WRL/0.06315)

661:  PAL = PQFL

662:  SWL == QXUL-QMUL

663:  SWRL == SWL/QXUL

664:  PXMRL == PQXL/PQML

665:  QUN == QFUN+ITFN

666:  QON == QFON+ITFRN75*QFON

667:  PQN == QUN/QON

668:  QFUN == QFON*PQFN

669:  QFON = QQON+QHON+QSON+QION+QXON

670:  LOG(PQFN) = B120060+B120061*LOG(PBN)+B120063*D8081

671:  QVUN == QFUN-QEUN-QOUN-ITQN

672:  QVON == QFON-QEON-QOON-ITQRN75*QFON

673:  PQVN == QVUN/QVON

674:  QEUN == QEON*PQEN

675:  LOG(QEON) = B120110+B120111*LOG(QFON)+B120112*LOG(PQEN)

676:  PQEN = B120120+B120121*(0.42*PENA1+0.18*PENA2+0.4*PENA3)

677:  QOUN == QOON*PQON

678:  LOG(QOON) = B120140+B120141*LOG(QFON)+B120142*TREND

679:  PQON = (CQNA*PQQA+CQNE*PQQE+CQNQ*PQQQ+CQNK*PQQK+CQNC*PQQC+CQNB*PQQB+CQNZ*PQQZ+CQNL*PQQL+CQNN*PQQN)/(CQNA+CQNE+CQNQ+
      CQNK+CQNC+CQNB+CQNZ+CQNL+CQNN)

680:  LOG(QLON) = B120160+B120161*LOG(QFON)+B120162*LOG(WRN/0.0657)+B120163*D7983+B120164*D8588
```

```
681:  ITN == ITFN+(+ITQN)
682:  ITFN*0.B = CCNC1*ITC1+CCNC2*ITC2+CCNC3*ITC3+CCNC4*ITC4+CCNC5*ITC5+CCNC6*ITC6+CCNC7*ITC7+CCNC8*ITC8+CCNC9*ITC9+CCNC10*
      ITC10+CCNC11*ITC11+CCNC12*ITC12+CCNC13*ITC13+CCNC14*ITC14+CCNC15*ITC15+CGN*ITG+CIRN*ITIR+CIGN*ITIG+CIGN*ITIQ*ITS+QXON/
      QVOT*ITX
683:  ITFRN = ITFN/(QYUN-ITFN)
684:  ITQN = B120190+B120191*QFUN+B120192*D74D76
685:  QYUN == QVUN+ITN
686:  QYON = QVON+ITRN75*QFON
687:  PQYN == QYUN/QYON
688:  WBN == WRN*NN
689:  LOG(WRN) = WN0+WN1*LOG(WRT)+WN2*(TREND-1900)
690:  SSFN == SSFRN*WBN/(1+SSFRN)
691:  GOSN == QVUN-WBN
692:  IUN == ION*PIN
693:  LOG(ION) = B120340+B120341*LOG(QFON)+B120342*LOG(PIN)+B120344*D8183
694:  LOG(PIN) = B120350+B120351*DEL(1 : LOG(CIQN*PAQ+CIKN*PAK+CICN*PAC+CIBN*PAB+CILN*PAL))+DEL(1 : ITIQR)+LOG(PIN(-1))
695:  NN = N6*1000
696:  LOG(NFN) = NN0+NN1*LOG(QFON)+NN2*(TREND-1900)+NN3*D8283
697:  HN = B120410+B120411*HT
698:  PHN = WRN/HN/(WRN75/HN75)
699:  QHUN = CHNC1*CUC1+CHNC2*CUC2+CHNC3*CUC3+CHNC4*CUC4+CHNC5*CUC5+CHNC6*CUC6+CHNC7*CUC7+CHNC8*CUC8+CHNC9*CUC9+CHNC10*CUC10
      +CHNC11*CUC11+CHNC12*CUC12+CHNC13*CUC13+CHNC14*CUC14+CHNC15*CUC15+CNU
700:  QHON = CHNC1*COC1+CHNC2*COC2+CHNC3*COC3+CHNC4*COC4+CHNC5*COC5+CHNC6*COC6+CHNC7*COC7+CHNC8*COC8+CHNC9*COC9+CHNC10*COC10
      +CHNC11*COC11+CHNC12*COC12+CHNC13*COC13+CHNC14*COC14+CHNC15*COC15+CNO
701:  PQHN == QHUN/QHON
702:  QSUN == QGON*PQGN
703:  QGON = CGN*CGO
704:  PQGN = PGN
705:  QIUN = (CINA*IUA+CINE*IUE+CINQ*IUQ+CINK*IUK+CINC*IUC+CINB*IUB+CINZ*IUZ+CINL*IUL+CINN*IUN+CIRN*IRU)*1.
706:  QION = (CINA*IOA+CINE*IOE+CINQ*IOQ+CINK*IOK+CINC*IOC+CINB*IOB+CINZ*IOZ+CINL*IOL+CINN*ION+CIRN*IRO)*1.+1.000000E-06
707:  PQIN == QIUN/QION
708:  QXUN == QXON*PQXN
709:  LOG(QXON) = B120570+B120571*TREND*D6676+B120572*TREND
710:  PQXN = PXN*EX/EXO
711:  QQUN == QQON*PQQN
712:  QQON = CQAN*QOOA+CQEN*QOOE+CQQN*QOOQ+CQKN*QOOK+CQCN*QOOC+CQBN*QOOB+CQZN*QOOZ+CQLN*QOOL+CQNN*QOON
713:  PQQN = PAN
714:  LOG(PEN) = B120750+B120751*LOG(PQEN)+B120752*LOG(PQQN)+B120753*LOG(WRN/0.0657)
715:  PAN = PQFN
716:  SWN == QXUN
717:  SWRN == SWN/QXUN
718:  PXMRN == PQXN/PQN
719:  QUT == QUA+QUE+QUQ+QUK+QUC+QUB+QUZ+QUL
720:  QOT == QOA+QOE+QOQ+QOK+QOC+QOB+QOZ+QOL
721:  PQT == QUT/QOT
722:  QFUT == QFUA+QFUE+QFUQ+QFUK+QFUC+QFUB+QFUZ+QFUL
723:  QFOT == QFOA+QFOE+QFOQ+QFOK+QFOC+QFOB+QFOZ+QFOL
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724:    PQFT == QFUT/QFOT
725:    QVUT == QVUA+QVUE+QVUQ+QVUK+QVUC+QVUB+QVUZ+QVUL
726:    QVOT == QVOA+QVOE+QVOQ+QVOK+QVOC+QVOB+QVOZ+QVOL
727:    PQVT == QVUT/QVOT
728:    QEUT == QEUA+QEUE+QEUQ+QEUK+QEUC+QEUB+QEUZ+QEUL
729:    QEOT == QEOA+QEOE+QEOQ+QEOK+QEOC+QEOB+QEOZ+QEOL
730:    PQET == QEUT/QEOT
731:    QOUT == QOUA+QOUE+QOUQ+QOUK+QOUC+QOUB+QOUZ+QOUL
732:    QOOT == QOOA+QOOE+QOOQ+QOOK+QOOC+QOOB+QOOZ+QOOL
733:    PQOT == QOUT/QOOT
734:    ITT == ITA+ITE+ITQ+ITK+ITC+ITB+ITZ+ITL
735:    ITFT == ITFA+ITFE+ITFQ+ITFK+ITFC+ITFB+ITFZ+ITFL
736:    ITFRT == ITFT/(QYUT-ITFT)
737:    ITQT == ITQA+ITQE+ITQQ+ITQK+ITQC+ITQB+ITQZ+ITQL
738:    ITMT == ITMA+ITME+ITMQ+ITMK+ITMC+ITML
739:    ITMRT == ITMT/(QMUT-ITMT)
740:    QYUT == QYUA+QYUE+QYUQ+QYUK+QYUC+QYUB+QYUZ+QYUL
741:    QYOT == QYOA+QYOE+QYOQ+QYOK+QYOC+QYOB+QYOZ+QYOL
742:    PQYT == QYUT/QYOT
743:    WBT == WBA+WBE+WBQ+WBK+WBC+WBB+WBZ+WBL
744:    LOG(WRT) = WT0+WT1*LOG(UR)+(1-WT2)*DEL(1 : LOG(PCH))+WT2*DEL(1 : LOG(PCH(-1)))+LOG(WRT(-1))
745:    SSFT == SSFA+SSFE+SSFQ+SSFK+SSFC+SSFB+SSFZ+SSFL
746:    SSFRT == SSFT/(WBT-SSFT)
747:    GOST == GOSA+GOSE+GOSQ+GOSK+GOSC+GOSB+GOSZ+GOSL
748:    IUT == IUA+IUE+IUQ+IUK+IUC+IUB+IUZ+IUL+IUN-IUG
749:    IOT == IOA+IOE+IOQ+IOK+IOC+IOB+IOZ+IOL+ION-IOG
750:    PIT == IUT/IOT
751:    NT == NAA+NEE+NQ+NK+NC+NB+NZ+NL
752:    NFT == NFA+NFE+NFQ+NFK+NFC+NFB+NFZ+NFL
753:    NIT == NIA+NIQ+NIK+NIC+NIB+NIZ+NIL
754:    HPT == NFA/NFT*HPA+NFE/NFT*HPE+NFQ/NFT*HPQ+NFK/NFT*HPK+NFC/NFT*HPC+NFB/NFT*HPB+NFZ/NFT*HPZ+NFL/NFT*HPL
755:    HT = B130410+B130411*(HAFT-HDAG)+B130412*T110410
756:    PHT == WRT/HT/(WRT75/HT75)
757:    QHUT == QHUA+QHUE+QHUQ+QHUK+QHUC+QHUB+QHUZ+QHUL+QHUN
758:    QHOT == QHOA+QHOE+QHOQ+QHOK+QHOC+QHOB+QHOZ+QHOL+QHON
759:    PQHT == QHUT/QHOT
760:    QGUT == QGUA+QGUE+QGUQ+QGUK+QGUC+QGUB+QGUZ+QGUL
761:    QGOT == QGOA+QGOE+QGOQ+QGOK+QGOC+QGOB+QGOZ+QGOL+1.000000E-06
762:    PQGT == PQQT
763:    QIUT == QIUA+QIUE+QIUQ+QIUK+QIUC+QIUB+QIUZ+QIUL
764:    QIOT == QIOA+QIOE+QIOQ+QIOK+QIOC+QIOB+QIOZ+QIOL
765:    PQIT == QIUT/QIOT
766:    QSUT == QSUA+QSUE+QSUQ+QSUK+QSUC+QSUL
767:    QSOT == QSOA+QSOE+QSOQ+QSOK+QSOC+QSOL
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768:   PQST == QSUT/QSOT
769:   QXUT == QXUA+QXUE+QXUQ+QXUK+QXUC+QXUZ+QXUL
770:   QXOT == QXOA+QXOE+QXOQ+QXOK+QXOC+QXOZ+QXOL
771:   PQXT == QXUT/QXOT
772:   QQUT == QQUA+QQUE+QQUQ+QQUK+QQUC+QQUB+QQUZ+QQUL
773:   QQOT == QQOA+QQOE+QQOQ+QQOK+QQOC+QQOB+QQOZ+QQOL
774:   PQQT == QQUT/QQOT
775:   QMUT == QMUA+QMUE+QMUQ+QMUK+QMUC+QMUL
776:   QMOT == QMOA+QMOE+QMOQ+QMOK+QMOC+QMOL
777:   PQMT == QMUT/QMOT
778:   PAT == (QFUT-QXUT-QSUT)/(QFOT-QXOT-QSOT)
779:   SWT == QXUT-QMUT
780:   SWRT == SWT/QXUT
781:   PXMRT == PQXT/PQMT
782:   XGU = B140010+B140011*(QXUA+QXUE+QXUQ+QXUK+QXUC+QXUL)
783:   XGO = B140020+B140021*(QXOA+QXOE+QXOQ+QXOK+QXOC+QXOL)
784:   PXG = XGU/XGO
785:   XRU = XRO*PXR
786:   DEL(1 : LOG(PXR)) = B140060+CXA*DEL(1 : LOG(PQHA))+CXE*DEL(1 : LOG(PQHE))+CXQ*DEL(1 : LOG(PQHQ))+CXK*DEL(1 : LOG(PQHK)
       )+CXC*DEL(1 : LOG(PQHC))+CXZ*DEL(1 : LOG(PQHZ))+CXL*DEL(1 : LOG(PQHL))+CXN*DEL(1 : LOG(PQHN))
787:   XSU = XSO*PXS
788:   XSO = B140080+B140081*(QXOZ+QXON+QXOR)
789:   LOG(PXS) = B140090+B140091*LOG(PXR)
790:   XGUS = XGU/EX
791:   XGOS = XGO/EX
792:   PXGS = XGUS/XGOS
793:   XUA = QXUA/(EX/100)
794:   XUE = QXUE/(EX/100)
795:   XUQ = QXUQ/(EX/100)
796:   XUK = QXUK/(EX/100)
797:   XUC = QXUC/(EX/100)
798:   XUZ = QXUZ/(EX/100)
799:   XUL = QXUL/(EX/100)
800:   XUN = QXUN/(EX/100)
801:   XOA = QXOA/(EXO/100)
802:   XOE = QXOE/(EXO/100)
803:   XOQ = QXOQ/(EXO/100)
804:   XOK = QXOK/(EXO/100)
805:   XOC = QXOC/(EXO/100)
806:   XOZ = QXOZ/(EXO/100)
807:   XOL = QXOL/(EXO/100)
808:   XON = QXON/(EXO/100)
809:   MGO = B140380+B140381*(QMOA+QMOE+QMOQ+QMOK+QMOC+QMOL)
810:   MGU = B140370+B140371*(QMUA+QMUE+QMUQ+QMUK+QMUC+QMUL)
811:   PGM = MGU/MGO
```

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812:  MCU = CUC15
813:  MCD = CDC15
814:  LOG(PCM) = CC150+CC151*(CMA*LOG(PQMA)+CME*LOG(PQME)+CMQ*LOG(PQMQ)+CMK*LOG(PQMK)+CMC*LOG(PQMC)+CMZ*LOG(PQMZ)+CML*LOG(
      PQML)+CMN*LOG(PQMN))*((1+ITCR15)/(1+ITCR1575))
815:  MSU = B140430+B140431*QMUR
816:  MSD = B140440+B140441*QMDR
817:  PMS = MSU/MSD
818:  MSUS = MGU/EX
819:  MGDS = MGD/EX
820:  PMSS = MSUS/MSDS
821:  MUA = QMUA/(EX/100)
822:  MUE = QMUE/(EX/100)
823:  MUQ = QMUQ/(EX/100)
824:  MUK = QMUK/(EX/100)
825:  MUC = QMUC/(EX/100)
826:  MUL = QMUL/(EX/100)
827:  MDA = QMDA/(EXD/100)
828:  MDE = QMDE/(EXD/100)
829:  MDQ = QMDQ/(EXD/100)
830:  MDK = QMDK/(EXD/100)
831:  MDC = QMDC/(EXD/100)
832:  MDL = QMDL/(EXD/100)
833:  EHUA1 = EHDA1*PEHA1
834:  EHUA2 = EHDA2*PEHA2
835:  EHUA3 = EHDA3*PEHA3
836:  LOG(EHDA1) = B150200+B150201*LOG(TREND-1900)
837:  LOG(EHDA2) = B150202+B150203*LOG(CDC4)+B150204*LOG(CDC9)
838:  LOG(EHDA3) = B150205+B150206*LOG(CDC4)+B150207*LOG(CDC5)
839:  EGUA2 = EGDA2*PEGA2
840:  EGUA3 = EGDA3*PEGA3
841:  LOG(EGDA2) = B150500+B150501*LOG(CGD+CND)+B150502*LOG(PEGA2)+B150503*LOG(PEGA3)
842:  LOG(EGDA3) = B150504+B150505*LOG(CGD+CND)+B150506*LOG(PEGA2)+B150507*LOG(PEGA3)
843:  ESUA1 = B150700+B150701*EFUA1+B150702*PEFA1
844:  ESUA2 = B150703+B150704*EFUA2+B150705*PEFA2
845:  ESDA1 = ESUA1/PDEA1
846:  ESDA2 = B150803+B150804*EFDA2+B150805*(PEFA2/PEFA2(-1))
847:  PESA1 = ESUA1/ESDA1
848:  PESA2 = ESUA2/ESDA2
849:  EXUA1 = EXDA1*PEXA1
850:  EXUA2 = EXDA2*PEXA2
851:  EXUA3 = EXDA3*PEXA3
852:  LOG(EXDA1) = B151100+B151101*LOG(EFDA1)+B151102*LOG(PEXA1)+B151103*LOG(PEXA2)
853:  LOG(EXDA2) = B151104+B151105*LOG(EFDA2)+B151106*LOG(PEXA1)+B151107*LOG(PEXA2)
854:  LOG(EXDA3) = B151108+B151109*LOG(EFDA3)+B151110*LOG(PEXA2)+B151111*LOG(PEXA3)
855:  EQUA1 = EUEA1+EUQA1+EUKA1+EUCA1
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856:  EQUA2 = EUAA2+EUEA2+EUQA2+EUKA2+EUCA2+EUBA2+EUZA2+EULA2+EUNA2+EULA1+EUNA1
857:  EQUA3 = EUAA3+EUEA3+EUQA3+EUKA3+EUCA3+EUBA3+EUZA3+EULA3+EUNA3
858:  EQDA1 = EDEA1+EDQA1+EDKA1+EDCA1
859:  EQDA2 = EDAA2+EDEA2+EDQA2+EDKA2+EDCA2+EDBA2+EDZA2+EDLA2+EDNA2+EDLA1+EDNA1
860:  EQDA3 = EDAA3+EDEA3+EDQA3+EDKA3+EDCA3+EDBA3+EDZA3+EDLA3+EDNA3
861:  PQEA1 = EQUA1/EQDA1
862:  PQEA2 = EQUA2/EQDA2
863:  PQEA3 = EQUA3/EQDA3
864:  EMUA1 = EMDA1*PEMA1
865:  EMUA2 = EMDA2*PEMA2
866:  EMUA3 = EMDA3*PEMA3
867:  EMDA1 = EHDA1+EQDA1+ESDA1+EXDA1-EFDA1
868:  EMDA2 = EHDA2+EGDA2+EQDA2+ESDA2+EXDA2-EFDA2
869:  EMDA3 = EHDA3+EGDA3+EQDA3+EXDA3-EFDA3
870:  EICA1 = EICRA1*EHUA1/(1+EICRA1)
871:  EICA2 = EICRA2*EHUA2/(1+EICRA2)
872:  EICA3 = EICRA3*EHUA3/(1+EICRA3)
873:  EIMA1 = EIMRA1*EMUA1/(1+EIMRA1)
874:  EIMA2 = EIMRA2*EMUA2/(1+EIMRA2)
875:  EIMA3 = EIMRA3*EMUA3/(1+EIMRA3)
876:  EFUA1 = EFDA1*PEFA1
877:  EFUA2 = EFDA2*PEFA2
878:  EFUA3 = EFDA3*PEFA3
879:  LOG(EFDA1) = B152400+B152401*LOG(EHDA1+EQDA1+ESDA1+EXDA1)+B152402*LOG(PEFA1/PEMA1)
880:  LOG(EFDA2) = B152403+B152404*LOG(EHDA2+EGDA2+EQDA2+ESDA2+EXDA2)+B152405*LOG(PEFA2/PEMA2)
881:  LOG(EFDA3) = B152406+B152407*LOG(EHDA3+EGDA3+EQDA3+EXDA3)+B152408*LOG(PEFA3/PEMA3)
882:  PAA1 = (EFUA1+EMUA1+EIMA1-EXUA1-ESUA1)/(EFDA1+EMDA1+EIMRA1B*EMDA1/(1+EIMRA1B)-EXDA1-ESDA1)
883:  PAA2 = (EFUA2+EMUA2+EIMA2-EXUA2-ESUA2)/(EFDA2+EMDA2+EIMRA2B*EMDA2/(1+EIMRA2B)-EXDA2-ESDA2)
884:  PAA3 = (EFUA3+EMUA3+EIMA3-EXUA3)/(EFDA3+EMDA3+EIMRA3B*EMDA3/(1+EIMRA3B)-EXDA3)
885:  EUAA2 = SAE2*QEUA*1000
886:  EUAA3 = SAE3*QEUA*1000
887:  SAE2 = KA1*(EA2+EA23*LOG(PEAA3)-LOG(PEAA2))+(KA2-KA1)*(EA2+EA23*LOG(PEAA3(-1))-LOG(PEAA2(-1)))+(1-KA2)*SAE2(-1)
888:  SAE3 = 1-SAE2
889:  EDAA2 = EUAA2/(PEAA2*PEAA275)
890:  EDAA3 = EUAA3/(PEAA3*PEAA375)
891:  EUEA1 = SEE1*QEUE*1000
892:  EUEA2 = SEE2*QEUE*1000
893:  EUEA3 = SEE3*QEUE*1000
894:  SEE1 = KE1*(EE1+EE12*(LOG(PEEA2)-LOG(PEEA1))+EE13*(LOG(PEEA3)-LOG(PEEA1)))+(KE2-KE1)*(EE1+EE12*(LOG(PEEA2(-1))-LOG(
      PEEA1(-1)))+EE13*(LOG(PEEA3(-1))-LOG(PEEA1(-1))))+(1-KE2)*SEE1(-1)
895:  SEE2 = KE1*(EE2+EE12*(LOG(PEEA1)-LOG(PEEA2))+EE23*(LOG(PEEA3)-LOG(PEEA2)))+(KE2-KE1)*(EE2+EE12*(LOG(PEEA1(-1))-LOG(
      PEEA2(-1)))+EE23*(LOG(PEEA3(-1))-LOG(PEEA2(-1))))+(1-KE2)*SEE2(-1)
896:  SEE3 = 1-SEE1-SEE2
897:  EDEA1 = EUEA1/(PEEA1*PEEA175)
898:  EDEA2 = EUEA2/(PEEA2*PEEA275)
899:  EDEA3 = EUEA3/(PEEA3*PEEA375)
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900:  EUQA1 = SQE1*QEUQ*1000
901:  EUQA2 = SQE2*QEUQ*1000
902:  EUQA3 = SQE3*QEUQ*1000
903:  SQE1 = KQ1*(EQ1+EQ12*(LOG(PEQA2)-LOG(PEQA1))+EQ13*(LOG(PEQA3)-LOG(PEQA1)))+(KQ2-KQ1)*(EQ1+EQ12*(LOG(PEQA2(-1))-LOG(
      PEQA1(-1)))+EQ13*(LOG(PEQA3(-1))-LOG(PEQA1(-1)))))+(1-KQ2)*SQE1(-1)
904:  SQE2 = KQ1*(EQ2+EQ12*(LOG(PEQA1)-LOG(PEQA2))+EQ23*(LOG(PEQA3)-LOG(PEQA2)))+(KQ2-KQ1)*(EQ2+EQ12*(LOG(PEQA1(-1))-LOG(
      PEQA2(-1)))+EQ23*(LOG(PEQA3(-1))-LOG(PEQA2(-1)))))+(1-KQ2)*SQE2(-1)
905:  SQE3 = 1-SQE1-SQE2
906:  EDQA1 = EUQA1/(PEQA1*PEQA175)
907:  EDQA2 = EUQA2/(PEQA2*PEQA275)
908:  EDQA3 = EUQA3/(PEQA3*PEQA375)
909:  EUKA1 = SKE1*QEUK*1000
910:  EUKA2 = SKE2*QEUK*1000
911:  EUKA3 = SKE3*QEUK*1000
912:  SKE1 = KK1*(EK1+EK12*(LOG(PEKA2)-LOG(PEKA1))+EK13*(LOG(PEKA3)-LOG(PEKA1)))+(KK2-KK1)*(EK1+EK12*(LOG(PEKA2(-1))-LOG(
      PEKA1(-1)))+EK13*(LOG(PEKA3(-1))-LOG(PEKA1(-1)))))+(1-KK2)*SKE1(-1)
913:  SKE2 = KK1*(EK2+EK12*(LOG(PEKA1)-LOG(PEKA2))+EK23*(LOG(PEKA3)-LOG(PEKA2)))+(KK2-KK1)*(EK2+EK12*(LOG(PEKA1(-1))-LOG(
      PEKA2(-1)))+EK23*(LOG(PEKA3(-1))-LOG(PEKA2(-1)))))+(1-KK2)*SKE2(-1)
914:  SKE3 = 1-SKE1-SKE2
915:  EDKA1 = EUKA1/(PEKA1*PEKA175)
916:  EDKA2 = EUKA2/(PEKA2*PEKA275)
917:  EDKA3 = EUKA3/(PEKA3*PEKA375)
918:  EUCA1 = SCE1*QEUC*1000
919:  EUCA2 = SCE2*QEUC*1000
920:  EUCA3 = SCE3*QEUC*1000
921:  SCE1 = KC1*(EC1+EC12*(LOG(PECA2)-LOG(PECA1))+EC13*(LOG(PECA3)-LOG(PECA1)))+(KC2-KC1)*(EC1+EC12*(LOG(PECA2(-1))-LOG(
      PECA1(-1)))+EC13*(LOG(PECA3(-1))-LOG(PECA1(-1)))))+(1-KC2)*SCE1(-1)
922:  SCE2 = KC1*(EC2+EC12*(LOG(PECA1)-LOG(PECA2))+EC23*(LOG(PECA3)-LOG(PECA2)))+(KC2-KC1)*(EC2+EC12*(LOG(PECA1(-1))-LOG(
      PECA2(-1)))+EC23*(LOG(PECA3(-1))-LOG(PECA2(-1)))))+(1-KC2)*SCE2(-1)
923:  SCE3 = 1-SCE1-SCE2
924:  EDCA1 = EUCA1/(PECA1*PECA175)
925:  EDCA2 = EUCA2/(PECA2*PECA275)
926:  EDCA3 = EUCA3/(PECA3*PECA375)
927:  EUBA2 = SBE2*QEUB*1000
928:  EUBA3 = SBE3*QEUB*1000
929:  SBE2 = 0.84
930:  SBE3 = 1-SBE2
931:  EDBA2 = EUBA2/(PEBA2*PEBA275)
932:  EDBA3 = EUBA3/(PEBA3*PEBA375)
933:  EUZA2 = SZE2*QEUZ*1000
934:  EUZA3 = SZE3*QEUZ*1000
935:  SZE2 = 0.95
936:  SZE3 = 1-SZE2
937:  EDZA2 = EUZA2/(PEZA2*PEZA275)
938:  EDZA3 = EUZA3/(PEZA3*PEZA375)
939:  EULA1 = SLE1*QEUL*1000
940:  EULA2 = SLE2*QEUL*1000
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941:  EULA3 = SLE3*DEUL*1000
942:  SLE1 = KL1*(EL1+EL12*(LOG(PELA2)-LOG(PELA1))+EL13*(LOG(PELA3)-LOG(PELA1)))+(KL2-KL1)*(EL1+EL12*(LOG(PELA2(-1))-LOG(
      PELA1(-1)))+EL13*(LOG(PELA3(-1))-LOG(PELA1(-1)))))+(1-KL2)*SLE1(-1)
943:  SLE2 = KL1*(EL2+EL12*(LOG(PELA1)-LOG(PELA2))+EL23*(LOG(PELA3)-LOG(PELA2)))+(KL2-KL1)*(EL2+EL12*(LOG(PELA1(-1))-LOG(
      PELA2(-1)))+EL23*(LOG(PELA3(-1))-LOG(PELA2(-1)))))+(1-KL2)*SLE2(-1)
944:  SLE3 = 1-SLE1-SLE2
945:  EOLA1 = EULA1/(PELA1*PELA175)
946:  EOLA2 = EULA2/(PELA2*PELA275)
947:  EOLA3 = EULA3/(PELA3*PELA375)
948:  EUNA1 = SNE1*DEUN*1000
949:  EUNA2 = SNE2*DEUN*1000
950:  EUNA3 = SNE3*DEUN*1000
951:  SNE1 = KN1*(EN1+EN12*(LOG(PENA2)-LOG(PENA1))+EN13*(LOG(PENA3)-LOG(PENA1)))+(KN2-KN1)*(EN1+EN12*(LOG(PENA2(-1))-LOG(
      PENA1(-1)))+EN13*(LOG(PENA3(-1))-LOG(PENA1(-1)))))+(1-KN2)*SNE1(-1)
952:  SNE2 = KN1*(EN2+EN12*(LOG(PENA1)-LOG(PENA2))+EN23*(LOG(PENA3)-LOG(PENA2)))+(KN2-KN1)*(EN2+EN12*(LOG(PENA1(-1))-LOG(
      PENA2(-1)))+EN23*(LOG(PENA3(-1))-LOG(PENA2(-1)))))+(1-KN2)*SNE2(-1)
953:  SNE3 = 1-SNE1-SNE2
954:  EONA1 = EUNA1/(PENA1*PENA175)
955:  EONA2 = EUNA2/(PENA2*PENA275)
956:  EONA3 = EUNA3/(PENA3*PENA375)
957:  EHUT = EHUA1+EHUA2+EHUA3
958:  EHOT = EHOA1+EHOA2+EHOA3
959:  PEHT = EHUT/EHOT
960:  EBUT = EBUA2+EBUA3
961:  EBOT = EBOA2+EBOA3
962:  PEBT = EBUT/EBOT
963:  ESUT = ESUA1+ESUA2
964:  ESOT = ESOA1+ESOA2
965:  PEST = ESUT/ESOT
966:  EXUT = EXUA1+EXUA2+EXUA3
967:  EXOT = EXOA1+EXOA2+EXOA3
968:  PEXT = EXUT/EXOT
969:  EQUT = EQUA1+EQUA2+EQUA3
970:  EQOT = EQOA1+EQOA2+EQOA3
971:  PEQT = EQUT/EQOT
972:  EMUT = EMUA1+EMUA2+EMUA3
973:  EMOT = EMOA1+EMOA2+EMOA3
974:  PEMT = EMUT/EMOT
975:  EICT = EICA1+EICA2+EICA3
976:  EICRT = EICT/(EHUT-EICT)
977:  EIMT = EIMA1+EIMA2+EIMA3
978:  EIMRT = EIMT/(EMUT-EIMT)
979:  EFUT = EFUA1+EFUA2+EFUA3
980:  EFOT = EFOA1+EFOA2+EFOA3
981:  PEFT = EFUT/EFOT
982:  EFPT = EFPA1+EFPA2+EFPA3
983:  PWT = (EFUA1+EMUA1)/(EFUT+EMUT)*PWA1+(EFUA2+EMUA2)/(EFUT+EMUT)*PWA2+(EFUA3+EMUA3)/(EFUT+EMUT)*PWA3
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984:  PAET = (EFUT+EMUT+EIMT-EXUT-ESUT)/(EFOT+EMOT+EIMRTB*EMOT/(1+EIMRTB)-EXOT-ESOT)
985:  EUAET = EUAA2+EUAA3
986:  EUEET = EUEA1+EUEA2+EUEA3
987:  EUQET = EUQA1+EUQA2+EUQA3
988:  EUKET = EUKA1+EUKA2+EUKA3
989:  EUCET = EUCA1+EUCA2+EUCA3
990:  EUBET = EUBA2+EUBA3
991:  EUZET = EUZA2+EUZA3
992:  EULET = EULA1+EULA2+EULA3
993:  EUNET = EUNA1+EUNA2+EUNA3
994:  EOAET = EOAA2+EOAA3
995:  EOEET = EOEA1+EOEA2+EOEA3
996:  EOQET = EOQA1+EOQA2+EOQA3
997:  EOKET = EOKA1+EOKA2+EOKA3
998:  EOCET = EOCA1+EOCA2+EOCA3
999:  EOBET = EOBA2+EOBA3
1000: EOZET = EOZA2+EOZA3
1001: EOLET = EOLA1+EOLA2+EOLA3
1002: EONET = EONA1+EONA2+EONA3
1003: PEAET = EUAET/EOAET
1004: PEEET = EUEET/EOEET
1005: PEQET = EUQET/EOQET
1006: PEKET = EUKET/EOKET
1007: PECET = EUCET/EOCET
1008: PEBET = EUBET/EOBET
1009: PEZET = EUZET/EOZET
1010: PELET = EULET/EOLET
1011: PENET = EUNET/EONET
1012: COST_KQ = PIQ*(1-(TC_WQ-LIPC-0/100))/(1-(TC_WQ-LIPC-0/100)**(10+1))
1013: COST_EQ = PQEQ*(LIPC+0/100-(TC_WQ-1))/(LIPC+0/100-(TC_EQ-1))*(1-(TC_EQ-LIPC-0/100)**(10+1))/(1-(TC_WQ-LIPC-0/100)**(10
      +1))
1014: LOG(IOQ) = IOQ83*D83+IOQ80*D80+IOQ7778*D7778+IOQ73*D73+IOQ72*D72+(1-IOQA1)*LOG(IOQ(-1))+IOQA1*(IOQA2-IOQA6*T+(1-IOQA3)
      *LOG(PHQ/COST_KQ)+(IOQA3/(1-IOQA7)-1)*LOG(1+IOQA8*(COST_EQ/COST_KQ)**(1-IOQA7))+LOG(IOQA4*(QFOQ-(1-TAUX_DQ)*QFOQ(-1))+
      IOQA5*(QFOQ(-1)-(1-TAUX_DQ)*QFOQ(-2))+(1-IOQA4-IOQA5)*(QFOQ(-2)-(1-TAUX_DQ)*QFOQ(-3))))
1015: NFFQ = EXP(NFQAR1*LOG(NFQ(-1)+NIQ(-1))+LOG(NFQ(-1)+NIQ(-1))+NFQ8283*D8283+NFQ7576*D7576+NFQA3+NFQA1*DEL(1 : LOG(QRQ*
      NHEQ/HQ))+NFQA2*(LOG(QRQ(-1)*NHEQ(-1)/HQ(-1))-LOG(NFQ(-1)+NIQ(-1)))-NFQAR1*(LOG(NFQ(-2)+NIQ(-2))+NFQ8283*D8283(-1)+
      NFQ7576*D7576(-1)+NFQA3+NFQA1*DEL(1 : LOG(QRQ(-1)*NHEQ(-1)/HQ(-1)))+NFQA2*(LOG(QRQ(-2)*NHEQ(-2)/HQ(-2))-LOG(NFQ(-2)+
      NIQ(-2)))))-NIQ
1016: QEOQ = QEOQ(-1)*EXP(QEOQ7880*D7880+QEOQ77*D77+QEOQA3+QEOQA2*DEL(1 : LOG(QRQ*EEQ))+QEOQA1*(LOG(QRQ(-1)*EEQ(-1))-LOG(
      QEOQ(-1))))
1017: EEQ = (1-TAUX_DQ)*EEQ(-1)+EEQA1*IOQ*IOQA8*(COST_KQ/COST_EQ)**IOQA7
1018: NHEQ = (1-TAUX_DQ)*NHEQ(-1)+NHEQA1*IOQ*(COST_KQ/PHQ)*(1+IOQA8*(COST_EQ/COST_KQ)**(1-IOQA7))*(1-IOQA3)/IOQA3
1019: QPQ = (1-TAUX_DQ)*QPQ(-1)+QPQA1*IOQ/(EXP(IOQA2-IOQA6*T)*(PHQ/COST_KQ)**(1-IOQA3)*(1+IOQA8*(COST_EQ/COST_KQ)**(1-IOQA7)
      )**(IOQA3/(1-IOQA7)-1))
1020: QQRQ = QRQ75*D75+QRQA1+QRQA2*LOG(QFOQ)+QRQA3*LOG(QPQ(-1))+QRQA4*(0.7*HQ-0.3*HQ(-1)-0.2*HQ(-2)-0.2*HQ(-3))
1021: COST_KK = PIK*(1-(TC_WK-LIPC-0/100))/(1-(TC_WK-LIPC-0/100)**(12+1))
1022: COST_EK = PQEK*(LIPC+0/100-(TC_WK-1))/(LIPC+0/100-(TC_EK-1))*(1-(TC_EK-LIPC-0/100)**(12+1))/(1-(TC_WK-LIPC-0/100)**(12
      +1))
1023: LOG(IOK) = IOK72*D72+IOK71*D71+IOK7374*D7374+IOK80*D80+(1-IOKA1)*LOG(IOK(-1))+IOKA1*(IOKA2-IOKA6*T+(1-IOKA3)*LOG(PHK/
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        COST_KK)+(IOKA3/(1-IOKA7)-1)*LOG(1+IOKA8*(COST_EK/COST_KK)**(1-IOKA7))+LOG(IOKA4*(QFOK-(1-TAUX_DK)*QFOK(-1))+IOKA5*(
        QFOK(-1)-(1-TAUX_DK)*QFOK(-2))+(1-IOKA4-IOKA5)*(QFOK(-2)-(1-TAUX_DK)*QFOK(-3))))

1024:   NFFK = EXP(NFKAR1*LOG(NFK(-1)+NIK(-1))+LOG(NFK(-1)+NIK(-1))+NFK7576*D7576+NFK71*D71+NFK79*D79+NFKA3+NFKA1*DEL(1 : LOG(
        QRK*NHEK/HK))+NFKA2*(LOG(QRK(-1)*NHEK(-1)/HK(-1))-LOG(NFK(-1)+NIK(-1)))-NFKAR1*(LOG(NFK(-2)+NIK(-2))+NFK7576*D7576(-1)
        +NFK71*D71(-1)+NFK79*D79(-1)+NFKA3+NFKA1*DEL(1 : LOG(QRK(-1)*NHEK(-1)/HK(-1)))+NFKA2*(LOS(QRK(-2)*NHEK(-2)/HK(-2))-LOG
        (NFK(-2)+NIK(-2)))))-NIK

1025:   QEOK = QEOK(-1)*EXP(QEOK7576*D7576+QEOK77*D77+QEOK74*D74+QEOK78*D78+QEOKA3+QEOKA2*DEL(1 : LOG(QRK*EEK))+QEOKA1*(LOG(
        QRK(-1)*EEK(-1))-LOG(QEOK(-1))))

1026:   EEK = (1-TAUX_DK)*EEK(-1)+EEKA1*IOK*IOKA8*(COST_KK/COST_EK)**IOKA7

1027:   NHEK = (1-TAUX_DK)*NHEK(-1)+NHEKA1*IOK*(COST_KK/PHK)*(1+IOKA8*(COST_EK/COST_KK)**(1-IOKA7))*(1-IOKA3)/IOKA3

1028:   QPK = (1-TAUX_DK)*QPK(-1)+QPKA1*IOK/(EXP(IOKA2-IOKA6*T)*(PHK/COST_KK)**(1-IOKA3)*(1+IOKA8*(COST_EK/COST_KK)**(1-IOKA7)
        )**(IOKA3/(1-IOKA7)-1))

1029:   QQRK = QRK75*D75+QRK69*D69+QRK7980*D7980+QRKA1+QRKA2*LOG(QFOK)+QRKA3*LOG(QPK(-1))+QRKA4*(0.7*HK-0.3*HK(-1)-0.2*HK(-2)-
        0.2*HK(-3))

1030:   COST_KC = PIC*(1-(TC_WC-LIPC-0/100))/(1-(TC_WC-LIPC-0/100)**(12+1))

1031:   COST_EC = PQEC*(LIPC+0/100-(TC_WC-1))/(LIPC+0/100-(TC_EC-1))*(1-(TC_EC-LIPC-0/100)**(12+1))/(1-(TC_WC-LIPC-0/100)**(12
        +1))

1032:   LOG(IOC) = IOC71*D71+IOC79*D79+IOC74*D74+IOC72*D72+(1-IOCA4)*LOG(IOC(-1))+IOCA4*(IOCA1-IOCA2*T+(1-IOCA3)*LOG(PHC/
        COST_KC)+(IOCA3/(1-IOCA7)-1)*LOG(1+IOCA6*(COST_EC/COST_KC)**(1-IOCA7))+LOG(IOCA5*(QFOC-(1-TAUX_DC)*QFOC(-1))+(1-IOCA5)
        *(QFOC(-1)-(1-TAUX_DC)*QFOC(-2))))

1033:   QQRC = QRC79*D79+QRC74*D74+QRCA1+QRCA2*LOG(QFOC)+QRCA3*LOG(QPC(-1))+QRCA4*(0.7*HC-0.3*HC(-1)-0.2*HC(-2)-0.2*HC(-3))

1034:   EEC = (1-TAUX_DC)*EEC(-1)+EECA1*(IOC*IOCA6*(COST_KC/COST_EC)**IOCA7)

1035:   NHEC = (1-TAUX_DC)*NHEC(-1)+NHECA1*(IOC*(COST_KC/PHC)*(1+IOCA6*(COST_EC/COST_KC)**(1-IOCA7))*(1-IOCA3)/IOCA3)

1036:   QPC = (1-TAUX_DC)*QPC(-1)+QPCA1*(IOC/(EXP(IOCA1-IOCA2*T)*(PHC/COST_KC)**(1-IOCA3)*(1+IOCA6*(COST_EC/COST_KC)**(1-IOCA7
        ))**(IOCA3/(1-IOCA7)-1)))

1037:   NFFC = EXP(NFCAR1*LOG(NFC(-1)+NIC(-1))+LOG(NFC(-1)+NIC(-1))+NFC74*D74+NFC71*D71+NFC75*D75+NFCA3+NFCA2*DEL(1 : LOG(QRC*
        NHEC/HC))+NFCA1*(LOG(QRC(-1)*NHEC(-1)/HC(-1))-LOG(NFC(-1)+NIC(-1)))-NFCAR1*(LOG(NFC(-2)+NIC(-2))+NFC74*D74(-1)+NFC71*
        D71(-1)+NFC75*D75(-1)+NFCA3+NFCA2*DEL(1 : LOG(QRC(-1)*NHEC(-1)/HC(-1)))+NFCA1*(LOG(QRC(-2)*NHEC(-2)/HC(-2))-LOG(NFC(-2
        )+NIC(-2)))))-NIC

1038:   QEOC = QEOC(-1)*EXP(QEOC82*D82+QEOC79*D79+QEOC73*D73+QEOC70*D70+QEOCA3+QEOCA2*DEL(1 : LOG(QRC*EEC))+QEOCA1*(LOG(QRC(-1
        )*EEC(-1))-LOG(QEOC(-1))))

1039:   LOG(QOOQ) = QOOQA1+QOOQA2*LOG(QFOQ)+QOOQA3*LOG(PQOQ/PQFQ)+QOOQA4*LOG(QRQ)

1040:   LOG(QOOK) = QOOKA1+QOOKA2*LOG(QFOK)+QOOKA3*LOG(PQOK/PQFK)+QOOKA4*LOG(QRK)

1041:   LOG(QOOC) = QOOCA1+QOOCA2*LOG(QFOC)+QOOCA3*LOG(PQOC/PQFC)+QOOCA4*LOS(QRC)

1042:   TC_EC = TC_WC

1043:   TC_WC = 0.5*PHC/PHC(-1)+0.5*PHC(-1)/PHC(-2)

1044:   TC_EK = TC_WK

1045:   TC_WK = 0.5*PHK/PHK(-1)+0.5*PHK(-1)/PHK(-2)

1046:   TC_EQ = TC_WQ

1047:   TC_WQ = 0.5*PHQ/PHQ(-1)+0.5*PHQ(-1)/PHQ(-2)

1048:   LOG(NFQ) = NQ4+NQ5*LOG(QFOQ)+NQ6*(TREND-1900)

1049:   LOG(NFK) = NK4+NK5*LOG(QFOK)+NK6*(TREND-1900)+0.04*D8592

1050:   LOG(NFC) = NC4+1.*LOG(QFOC)+NC6*(TREND-1900)+0.06*D8592

1051:   QRQ = QFOQ/QPQ

1052:   QRK = QFOK/QPK

1053:   QRC = QFOC/QPC
```

APPENDIX B

List of variables

Variables with post positive U are in current prices

Variables with post positive O are in constant 1975-prices

Variables with pre positive P are price-index

Subscript i refers to the branches of the model

Subscript c refers to the categories of private household consumption

Subscript e refers to types of fuels

National Accounts

CHU, CHO, PCH	Final consumption of households on the economic territory
CGU, CGO, PCG	Collective consumption of the general government
IU, IO, PI	Gross fixed capital formation
SU, SO, PS	Change in stocks
XU, XO, PX	Exports of goods and services
MU, MO, PM	Imports of goods and services
YU, YO, PY	Gross domestic product at market prices
IT	Total taxes linked to production and import (indirect taxes)
ITM	Taxes linked to imports
ITF	Taxes linkes to production
ITQ	Other indirect taxes linked to production net of subsidies
ITR	Total indirect tax rate
SUB	Subsidies on products
SUBR	Subsidy rate with respect to gross domestic product at factor costs
VU, VO, PV	Gross domestic product at factor costs
YN	Net factor income from the rest of the world: compensation of employees
YK	Net current income from the rest of the world: property and entrepreneurial
TXM	Net current transfers from the rest of the world
YNN	Net national disposable income
WBU	Total wage income
WBF, WBFR	Wage income and wage rate in enterprises
WBG, WBGR	Wage income and wage rate in the general government
DPU	Total consumption of fixed capital

DPUF	Consumption of fixed capital in enterprises
SSF, SSFR	Social security contributions and rate by employees
SSH, SSHR	Social security constributions and rate of households
YSSG	Social security constributions, receipts of general government
YSSP	Social security constributions, receipts of enterprises
SBH	Social benefits, receipts of households
SBG	Social benefits, expenditures of general government
SBF	Social benefits, expenditures of enterprises
GOSH	Gross operating surplus of households
GOSG	Gross operating surplus of general government
GOSF	Gross operating surplus of enterprises
IDH	Net interests, dividends and other property income, receipts of households
IDG	Net interests, dividends and other property income, payments by general government
IDF	Net interests, dividends and other property income, payments by enterprises
DTH, DTHR	Direct taxes and tax rate of households
DTF, DTFR	Direct taxes and tax rate of enterprises
YDTG	Direct taxes, receipt of general government
QCUH	Other current transfers received by households
QCUF	Other current transfers received by enterprises

SH, SHR	Gross savings and gross savings rate of households
SF, SFR	Gross savings and gross savings rate of enterprises
YDH	Gross disposable income of households
IHU	Gross fixed capital formation and change in stocks of households
IFU	Gross fixed capital formation and change in stocks of enterprises
SXM, SXMR	Trade balance and ratio with respect to exports
SW, SWS	Balance of payments in Danish Crowns and US Dollars
PXM	Terms of trade
IRU, IRO, PIR	Gross fixed capital formation in construction of dwellings
IUG, IOG, PIG	Gross fixed capital formation by general government
IQU, IQO, PIQ	Gross fixed capital formation by enterprises

Various National Aggregates

NPQ	Total population
NPA	Population between the age of 15 and 65
NAT	The active population
NAR	The ratio of active population
N	Total employment
NI	Self-employed
NG	Wage and salary earners in general government
NF	Total wage and salary earners excl. general government

ND	Total wage and salary earners (NF + NG)
U	Unemployment
UR	Unemployment rate
H	Average labour time in hours per year
HAFT	Negociated labour time per year
HDAG	Irregular holidays
VQNR, VQHR	Average productivity per year and per hour
WPCR	Real average wage rate
SI, LI	Short term and long term interest rate
EX	Exchange rate, national currency per $
KRKURS	Exchange rate, weighted average of foreign currencies per Danish Crown
QYUI, QYOI	Imputed output of bank services at market prices
DITK	VAT deductive on purchases of capital goods; def. equal to zero
ITG, ITGR	Indirect taxes and tax rate on collective consumption; def. equal to zero
ITIR, ITIRR	Indirect taxes and tax rate on construction of dwellings
ITIG, ITIGR	Indirect taxes and tax rate on gross fixed capital formation by non-market services
ITIQ, ITIQR	Indirect taxes and tax rate on gross fixed capital formation by other branches
ITS, ITSR	Indirect taxes and tax rate on changes in stocks
ITX	Indirect taxes on exports of goods and services
PCW	Consumer price index

Consumption

CU_c, CO_c, PC_c	Consumption of households by category
IT_c, ITCR1-15	Indirect taxes and tax rates per consumption category
CNU, CNO, PCN	Collective consumption of private non-profit institutions

Consumption categories:

c1	Food, beverages and tobacco
c2	Clothing and footwear
c3	Gross rents
c4	Fuels for domestic use
c5	Power for domestic use
c6	Domestic services
c7	Furniture, furnishings and household equipments
c8	Personal transport equipment
c9	Fuels for personal transportation
c10	Purchased trasnport
c11	Communication
c12	Medical care and health expenses
c13	Recreation, entertainment, education and cultural services
c14	Miscellaneous goods and services
c15	Expenditures of residents abroad

Branches

A : Agriculture, forestry and fishery products
E : Fuel and power products
Q : Manufacturing products: intermediate
K : Manufacturing products: equipment
C : Manufacturing products: consumption
B : Building and construction
Z : Transport and communication
L : Other market services
N : Non-market services

QU_S, QO_S, PQ_S	Output at market prices by branch
QFU_S, QFO_S, PQF_S	Output at factor costs by branch
QVU_S, QVO_S, PQV_S	Value added at factor costs by branch
QEU_S, QEO_S, PQE_S	Intermediary inputs of fuel and power by branch
QOU_S, QOO_S, PQO_S	Other intermediary inputs by branch
IT_S	Total indirect taxes by branch
ITF_S, $ITFR_S$	Indirect taxes and tax rates linked to production by branch
ITQ_S	Other taxes linked to production net of subsidies
ITM_S, $ITMR_S$	Indirect taxes and tax rates linked to imports per branch
QYU_S, QYO_S, PQY_S	Gross value added at market prices by branch
WB_S, WR_S	Wage bill and wage rate by branch
SSF_S, $SSFR_S$	Social security contributions of employers and rate with respect to gross wages by branch
GOS_S	Gross operating surplus by branch

IU_S, IO_S, PI_S	Gross fixed capital formation by ownership branch
N_S	Total employment by branch
NF_S	Wage and salary earners by branch
NI_S	Self employed by branch
H_S	Hours worked per man-year by branch
PH_S	Cost price index per hour worked by branch
QP_S	Production capacity by branch (only branches Q, K and C)
QR_S	Capacity utilization rate by branch (only branches Q, K and C)
QHU_S, QHO_S, PQH_S	Deliveries by branch to final consumption of households
QGU_S, QGO_S, PQG_S	Deliveries by branch to final consumption of the general government
QIU_S, QIO_S, PQI_S	Deliveries by branch to gross fixed capital formation
QSU_S, QSO_S, PQS_S	Deliveries by branch to variations of stocks
QXU_S, QXO_S, PQX_S	Deliveries by branch to exports
QQU_S, QQO_S, PQQ_S	Deliveries by branch to intermediary consumption
QMU_S, QMO_S, PQM_S	Imports from foreign branches similar to the domestic branches
PB_S	Computed cost index by branch
PA_S	Computed absorption price by branch
SW_S, SWR_S	Trade balance and ratio w.r.t. exports by branch
$PXMR_S$	Terms of trade by branch
TC_E_S, TC_W_S	Help variables in production (only branches Q, K and C)
COST_K, COST_K	Capital and energy cost variables in production function (only branches Q, K and C)

EE_S	Full capacity optimal energy consumption (only branches Q, K and C)
NHE_S	Full capacity optimal labour input (only branches Q, K and C)
NFF_S	Calculated labour input from production function (only branches Q, K and C)
QQR_S	Calculate capacity utilization rate from production function (only branches Q, K and C)

International Accounts

XGU, XGO, PXG	Total exports of goods, excl. expenditures of non-residents on the economic territory
XRU, XRO, PXR	Expenditures of non-residents on the economic territory
XSU, XSO, PXS	Exports of non-factor services
XGUS, XGOS, PXGS	Total exports of goods, excl. expenditures of non-residents in US $
XU_S, XO_S, PX_S	Total exports by branches in US $
MGU, MGO, PMG	Total imports of goods, excl. expenditures of residents abroad
MCU, MCO, PCM	Expenditures of residents abroad
MSU, MSO, PMS	Imports of non-factor services
MGUS, MGOS, PMGS	Total imports of goods, excl. expenditures of residents abroad in US $
MU_S, MO_S, PM_S	Total imports by branches in US $

Energy products

Fuel types e:

A1 : solid fuels
A2 : fluid fuels
A3 : electricity
T : Total

EHU_e, EHO_e, PEH_e	Deliveries of energy to final consumption of households
EGU_e, EGO_e, PEG_e	Deliveries of energy to final consumption of the general government
ESU_e, ESO_e, PES_e	Deliveries of energy to variations of stocks
EXU_e, EXO_e, PEX_e	Deliveries of energy to exports
EQU_e, EQO_e, PEQ_e	Deliveries of energy to intermediary consumption of branches
EMU_e, EMO_e, PEM_e	Imports of energy
EIC_e, $EICR_e$	Indirect taxes and tax rates on energy consumption of households
EIM_e, $EIMR_e$	Indirect taxes and tax rates on imported energy
EFU_e, EFO_e, PEF_e	Effective production of primary energy at factor costs
PA_e	Absorption price index on energy products
EU_{ie}, EO_{ie}, PE_{ie}	Intermediate consumption of energy by types and branches
S_{ie}	Share of fuel type e in energy budget of branch i.

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Abstract (Max. 2000 char.)

This report presents the first version of the Danish HERMES model which is a macro-economic model developed for the Commission of the European Communities to be used by the Commission for economic analyses and forecasts. Similar models are developed for the other EEC countries and in order to perform multinational studies the national models are interlinked into a multinational model.
The model is a medium-term econometric model where special attention is given to analysing structural changes, capacity effects of investments and the energy-economy interactions. In the Danish model production is determined for 9 branches and the total private consumption is divided into 15 categories of consumer goods. Capacity effects of investments are attempted described by the introduction of a putty-clay production function and the energy-economy interactions are analysed by treating energy as a separate factor of production and as specific categories of consumer goods.
Besides presenting the overall structure and the specific equations chosen for the first version of the Danish model the report gives an overview over the alternative specifications tested but rejected for the present version of the model. The report is concluded with an analysis of the model's ability to describe the past development and a few multiplicator analyses for central variables of the model.

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CONSUMER PRODUCTS; ECONOMICS; ENERGY CONSUMPTION; ENERGY DEMAND; EQUATIONS; HOUSEHOLDS; INDUSTRY; MATHEMATICAL MODELS; PRICES; PRODUCTION; SUPPLY AND DEMAND; TRADE; WAGES

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